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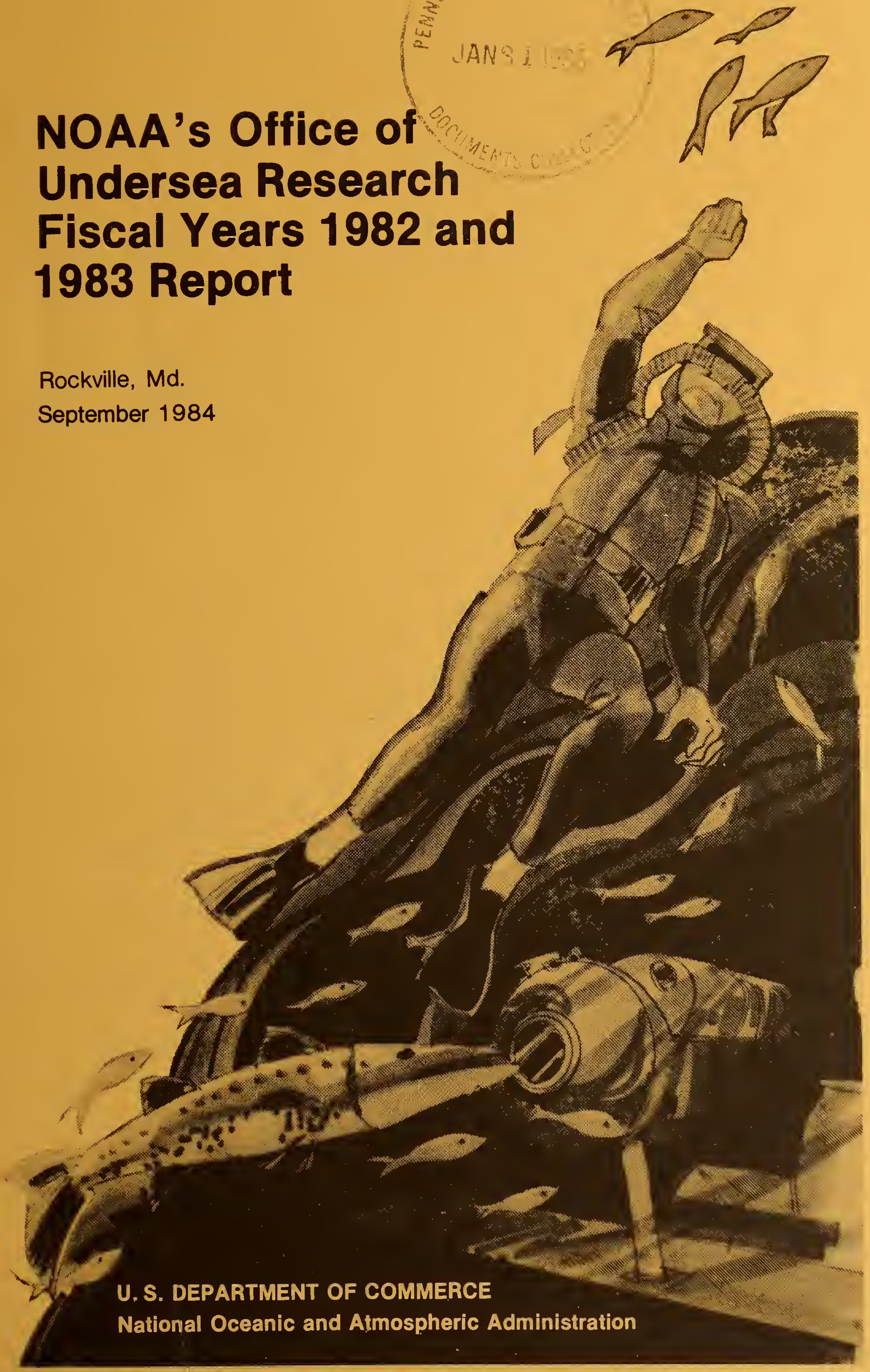
NOAA's Office of Undersea Research Fiscal Years 1982 and 1983 Report

Rockville, Md.
September 1984



U. S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration

NOAA's Office of Undersea Research Fiscal Years 1982 and 1983 Report

Rockville, Md.
September 1984

U.S. DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary

National Oceanic and Atmospheric Administration
John V. Byrne, Administrator

Office of Oceanic and Atmospheric Research
Ned A. Ostenso, Acting Assistant Administrator

Office of Undersea Research
Elliott Finkle, Director

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LIST OF ABBREVIATIONS AND ACRONYMS

ABS	American Bureau of Shipping
BOSP	Board on Ocean Science and Policy (formerly known as Ocean Science Board)
DAN	Diving Accident Network, Duke University Medical Center
FAMOUS	French American Mid-Ocean Undersea Study
FISSHH	First International Saturation Study of Herring and Hydroacoustics
FLARE	Florida Aquanaut Research Expedition
fsw	feet of seawater
FY	Fiscal Year
HBF	Harbor Branch Foundation
IGUANA	Intergovernmental Undersea Atomic Neutron Activation project
JAMSTEC	Japan Marine Science and Technology Center
LRT	Launch, Retrieval and Transport Vehicle
MUS&T	Manned Undersea Science and Technology Program (NOAA)
NITROX	Nitrogen-Oxygen Breathing Mixture
NOAA	National Oceanic and Atmospheric Administration
NURP	National Undersea Research Program (NOAA)
OAR	Office of Oceanic and Atmospheric Research (NOAA)
ONR	Office of Naval Research
OSB	Ocean Science Board (now known as Board on Ocean Science and Policy)
OUR	Office of Undersea Research
PTC	Personnel Transfer Capsule
ROV	Remotely Operated Vehicle
R/V	Research Vessel
SCORE	Scientific Cooperative Operational Research Expedition
SCUBA	Self Contained Underwater Breathing Apparatus
SECURE	Southeastern Consortium for Undersea Research Efforts
UJNR	United States-Japan Cooperative Program in Natural Resources
UMS	Undersea Medical Society
UNC-W	University of North Carolina at Wilmington
UNOLS	University National Oceanographic Laboratory System
USC	University of Southern California

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PREFACE

The primary responsibility of the Office of Undersea Research (OUR) is to support NOAA's legislated ocean-related mission by providing an ensemble of undersea equipment, facilities, and capabilities to extend the ability of marine researchers beyond the limits imposed by traditional laboratory and ship-based modes of research. To meet this responsibility, OUR has developed a national undersea research program of facilities, submersibles, and research on diving and diver safety to facilitate the accomplishment of NOAA's research goals and objectives in four major areas of the agency's responsibility: marine pollution, fisheries, ocean services, and seafloor properties and processes.

The purpose of this report is to highlight the achievements of OUR in helping NOAA to carry out its Congressionally mandated responsibilities in these four areas. The report summarizes program activities initiated, continued, or completed in the period October 1, 1981, through September 30, 1983. During this 2-year period, OUR activities included the provision of facilities and financial support for undersea research activities that involved habitats and submersibles, the conduct of research related to diving research and development, and the encouragement of joint international and interagency underwater research projects, all conducted in a way that ensures that NOAA's undersea research needs are met in the most responsive and cost-effective manner. These program activities also included support of cooperative international projects with France, Kuwait, and Japan, and the establishment of an annual symposium series devoted to the presentation of scientific papers describing sponsored research projects.

DIRECTOR'S FOREWORD

The National Oceanic and Atmospheric Administration (NOAA) first recognized the need for an undersea research program in 1971. With a modest budget, the program began by supporting that segment of marine research which requires man-in-the-sea investigations either *in situ* or in a one-atmosphere vehicle. NOAA's purpose was to augment other and more conventional techniques of conducting marine research. In addition, projects that supported diving technology, research, and workshops related to the health and safety of divers have been an integral part of the program.

Following reorganization of the program in 1980, the agency's major undersea objective was to establish a NOAA National Undersea Research Program through a network of research support facilities. These facilities used existing undersea platforms and state-of-the-art technology to enable scientists to work more efficiently under the sea.

This report describes the program's achievements for the 1982-83 period. Most notably, these included baseline and monitoring studies in potential oil and gas drilling areas, an assessment of halibut longline gear, and research on the long-term effects of deep ocean disposal of dredged materials. This report also indicates that the agency's future plans call for the continuing development of the NOAA National Undersea Research Program network to complement the five active programs presently located in St. Croix, North Carolina, Hawaii, California, and Connecticut.

Finally, I would like to take this opportunity to acknowledge the joint participation of the U.S. science community in helping NOAA meet its mandated ocean-related mission responsibilities through the National Undersea Research Program.

Rockville, Maryland
September, 1984

Elliott Finkle,
Director

SECTION I

HISTORY AND OVERVIEW OF NOAA'S UNDERSEA RESEARCH PROGRAMS

BACKGROUND

The Congress of the United States established the National Oceanic and Atmospheric Administration in 1970 and gave the new agency the responsibility for the management of marine resources and their habitats and for conducting and sponsoring ocean-related research. Specifically, the agency received a Congressional mandate to support research on the causes and effects of marine pollution, the influence of the Earth's oceans on climate and weather, and the utilization of marine sanctuaries.

The Manned Undersea Science and Technology (MUS&T) Office was established in 1971 to integrate and oversee NOAA's undersea research efforts, and it fulfilled these functions until 1980. At that time, the present Office of Undersea Research (OUR) was organized under the Office of Oceanic and Atmospheric Research (OAR). The following paragraphs briefly summarize the major activities and programs carried out by the MUS&T office in the first decade of NOAA's existence. The programs conducted by the Office of Undersea Research in the period 1980-81 are also described.

MAJOR ASPECTS OF NOAA'S UNDERSEA RESEARCH PROGRAM, 1971-80

Manned Undersea Activity

From its inception, one of the MUS&T Office's most important functions was the encouragement and coordination of Federal nonmilitary and civilian programs in manned undersea activity. Although human beings have salvaged wrecks and built structures underwater for hundreds of years, it was not until the advent of technologies such as self-contained underwater breathing apparatus (SCUBA), deep-sea submersibles, underwater habitats, and saturation diving in the post-World War II period that manned undersea activity became important as a marine research tool.

The development of operational seafloor habitats in the 1960's, such as the U.S. Navy's SEALAB and General Electric's TEKTITE I, encouraged in-situ research activities in the underwater environment. Habitats, submersibles, and remotely operated vehicles, which permit scientist/aquanauts to observe, monitor, manipulate, and understand the ocean environment at first hand, became the cornerstones of NOAA's undersea research program.

Among the four basic objectives assigned to the newly established MUS&T office in 1971 were three goals directly related to manned undersea activity (MUS&T Annual Report, FY 1972). These objectives were:

1. Provide manned underwater and operational support for NOAA investigations involving marine resources and environmental problems which require human subsurface observations and data collection
2. Foster and coordinate manned undersea science projects with other Federal and state agencies, industry, research institutions, and universities
3. Develop scientific and technical criteria for civilian undersea facilities and platforms through the experience gained by using available habitats and submersibles

In the period 1971-80, MUS&T conducted a vigorous program of habitat-based and submersible research, including projects that involved use of the habitats EDALHAB, HYDROLAB, LA CHALUPA, HELGOLAND, and SUBIGLOO, and the research submersibles JOHNSON SEA-LINK, ALVIN, NEKTON ALPHA, BETA, and GAMMA, DEEP DIVER, DEEPSTAR 2000, DEEP QUEST, PC-8, DIAPHUS, and BEAVER MARK IV. More than 100 academic and research institutions and 20 Federal agencies have participated in these research projects. The scientist/aquanauts who carried out these programs logged more than 300,000 hours of seafloor "bottom time" during these missions and conducted more than 1,000 dives.

Major undersea research programs organized and sponsored by NOAA in its first decade include the Bahama Banks Research Program, Project FLARE (Florida Aquanaut Research Expedition), the international HELGOLAND program, the SCORE (Scientific Cooperative Operational Research Expedition) mission, the international FISSHH (First International Saturation Study of Herring and Hydroacoustics) projects, the IGUANA (Intergovernmental Undersea Atomic Neutron Activation) program, and the French-American FAMOUS (French-American Mid-Ocean Undersea Study) cooperative oceanographic undertaking. The success and public appeal of these programs led to Congressional interest in the availability of U.S. manned underwater research facilities and in fulfilling the needs of the U.S. undersea research community. The OCEANLAB program and the UNOLS Research Submersible Study were initiated by MUS&T in response to this interest.

The OCEANLAB Program

The MUS&T Office prepared a concept paper on the "Development and Utilization of an American Underwater Laboratory, OCEANLAB" in 1975. The paper recommended that the United States develop the systems capability to perform underwater research in support of U.S. energy, mineral, and marine resource interests in its offshore areas. The paper envisioned a mobile laboratory with a depth capability of approximately 1,000 feet of seawater that was capable of operating autonomously in waters ranging from the temperate zone off California to the rough, cold waters characteristic of the offshore areas of New England.

In 1976, Congress appropriated funds for a preliminary needs analysis and engineering design phase study for OCEANLAB. The Senate Report (No. 94-964) accompanying the appropriations bill explained:

> "The purpose of such a laboratory would be to provide a national underwater ocean habitat for research related to living and nonliving marine resources....the OCEANLAB....would be the focal point for programs to utilize diver-scientists to study and assess the fish stocks of the Continental Shelf...."

The MUS&T Office responded to this Congressional initiative by inaugurating a series of workshops attended by groups of potential OCEANLAB users. These workshops ensured that the OCEANLAB facility would have the technology necessary to improve the effectiveness of manned undersea research activities.

During 1977-78, the MUS&T Office conducted a comprehensive review of the OCEANLAB program, in consultation with the Congress, the Office of Management and Budget, the Department of Commerce, and members of the undersea research community. This OCEANLAB Concept Review led in 1978 to a redirection of the program along the following lines:

- Analysis of the science community's requirements for manned undersea facilities
- Analysis of existing U.S. undersea systems
- Development of requirements for advanced capability systems and technologies
- Expansion of the cooperative underwater laboratory program along regional lines

The Ocean Science Board (now known as the Board on Ocean Science and Policy) of the National Research Council performed an analysis of the scientific needs and requirements of the research community and determined that there were many important scientific research topics that would require OCEANLAB capabilities. In addition, the Board identified many competent research scientists interested in using undersea facilities and specialized underwater research techniques to pursue these topics. The Board recommended that NOAA expand its existing undersea research program by increasing the use of already available underwater facilities, such as habitats, and by encouraging scientific studies involving the use of techniques such as saturation diving and research tools such as submersibles and remotely controlled vehicles.

The Board also urged NOAA's undersea program to support engineering studies, development programs, and research efforts aimed at developing the underwater technology needed to advance the state of undersea research. The OCEANLAB Concept Review concluded that certain university-based oceanographic institutions were ideally equipped and situated to operate NOAA's OCEANLAB facilities.

UNOLS Research Submersible Study

In conjunction with the National Science Foundation and the U.S. Navy's Office of Naval Research, NOAA supported a study by the University National Oceanographic Laboratory System (UNOLS) to determine the short- and long-term needs of the science community for research submersibles. The study assessed the operational systems (submersibles, support ships, and handling equipment) needed for continued submersible-based research and the cost-effectiveness of alternative systems.

The UNOLS study's headquarters was located at the Lamont-Doherty Geological Observatory, and the study team consisted of three components: a Project Office, a Submersible Science Assessment Panel, and a Submersible Science Facilities Planning Task Force. The UNOLS Science Panel's chief responsibility was to evaluate the role of submersible-based science in the overall context of ocean science and technology research. The UNOLS report was completed in FY 1982, and the report's findings and recommendations are described in detail in section IV of this annual report.

Technology Transfer

Another major component of NOAA's undersea research program has been the sponsorship of workshops, studies, and reports on topics ranging from diver safety to the development of decompression tables for excursion dives. Highlights of this aspect of NOAA's program have included publication of the first edition of the *NOAA Diving Manual* in 1975 and the second edition in 1979 (fig. I-1), annual compilation of fatality statistics for the U.S. civilian diving population, and the development of a symposium series devoted to the presentation of scientific papers on NOAA-sponsored research projects. OUR's technology transfer program involves the development of reports and papers by the office staff, sponsorship of workshops and publication of their proceedings, and direct funding of research projects that are reported on in the open literature.

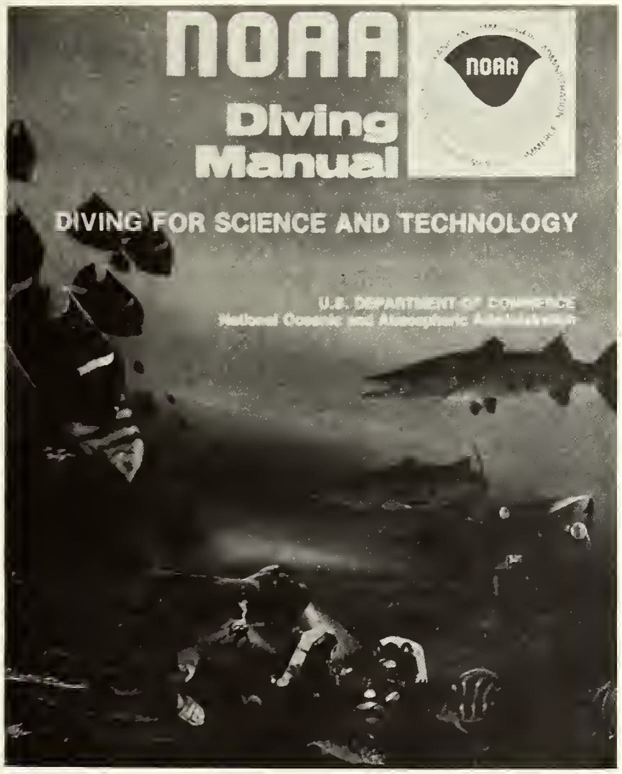

NOAA
Diving Manual
NOAA
DIVING FOR SCIENCE AND TECHNOLOGY
U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration

Figure I-1.—Cover of the *NOAA Diving Manual* (2nd edition).

International Activities

Encouraging cooperative international projects related to undersea research has been an increasingly important part of NOAA's undersea research program. Early efforts included participation in the French-American Mid-Ocean Undersea Study (FAMOUS) and joint U.S.-Federal Republic of Germany habitat projects involving the German habitat HELGOLAND and the American undersea platform HYDROLAB. NOAA has sponsored undersea research programs with France, the Federal Republic of Germany, the USSR, Japan, Great Britain, Saudi Arabia, Kuwait, Norway, Poland, and Canada. International activities conducted during fiscal years 1982 and 1983 are described in section IV.

Federal Interagency Programs

NOAA's role as coordinator and sponsor of Federal nonmilitary and civilian manned undersea activities has led to many joint Federal agency projects. In addition to various NOAA components, such as Sea Grant, the Atlantic Oceanographic and Meteorological Laboratory, the National Ocean Service, the National Marine Fisheries Service, and the Sea-Air Interaction Laboratory, many Federal agencies have joined with the Office of Undersea Research or its predecessor to participate in interagency undersea research activities. Participating Federal agencies have included the U.S. Navy, the Occupational Safety and Health Administration, the U.S. Coast Guard, the National Institute for Occupational Safety and Health, the Corps of Engineers, the Smithsonian Institution, the National Institutes of Health, the Environmental Protection Agency, the Energy Research and Development Administration, the Nuclear Regulatory Commission, Department of the Interior, and the National Bureau of Standards.

Diving Research and Safety

Another aspect of NOAA's undersea research program involves diving-related research and development. Projects in this category have ranged from studies of the incidence of dysbaric osteonecrosis among NOAA divers to the construction of a portable inflatable recompression chamber and development of a wrist-worn digital decompression computer.

RESEARCH PROGRAM OF THE OFFICE OF UNDERSEA RESEARCH, 1980-81

Based on the results of an in-depth internal review of NOAA's undersea research program and input from the UNOLS report and the Board on Ocean Science and Policy study, the agency in 1980 articulated the following policies and goals for its undersea research program:

- Continued support for existing undersea research facilities, based on NOAA's needs and priorities
- Development of new cooperative regional undersea laboratories
- Continued support for the deep-diving research submersible ALVIN
- Funding and other support for diving research and development

In 1980, the Office of Undersea Research carried out these policies through an integrated program of deep- and shallow-water submersible research, national undersea research projects, diving safety research, and interagency and international science missions.

Deep-Water Submersible Research

The deep-water submersible ALVIN and its support ship LULU have formed the cornerstone of NOAA's deep-water research program since its inception. In 1981, the tri-agency (NOAA, U.S. Navy, and National Science Foundation) support agreement governing use of the ALVIN/LULU system was extended for an additional 3-year period. Two major research projects, the St. Croix Submersible Expedition and the Ecuador Rift-Inca Transform-Galapagos Rift Study, were conducted from the ALVIN during FY 1981. A total of 13 dives were performed, to depths as great as 4,000 meters.

Shallow-Water Submersible Research

The shallow-water submersible research program focused in FY 1981 on the use of the submersibles JOHNSON SEA-LINK and NEKTON GAMMA; the SEA-LINK is owned and operated by the Harbor Branch Foundation, while the NEKTON GAMMA belongs to General Oceanographics. A cooperative agreement between NOAA and the Harbor Branch Foundation permitted the two organizations to conduct underwater research in areas of interest to them both and to share expenses and resources. The major shallow-water submersible project conducted in 1981 was a five-part SEA-LINK cruise that began in Woods Hole, Massachusetts, and ended in the waters off the coast of southeast Florida. Each of the five "legs" of the cruise had a distinct purpose and involved different scientists and organizations. The principal findings of the SEA-LINK cruise were:

- Surface sediments are continuously reworked and redistributed within the submarine canyons in the offshore oil and gas drilling areas.
- Substrate and fauna in the submarine canyon are free of PCB's and detectable levels of hydrocarbons.
- Trace metals occur in low levels in sediment and fauna, except copper and zinc, which occur in moderately high amounts in the tissues of mollusks and crustaceans.
- Pre-oil and gas well drilling baselines were established for tilefish populations and their distributions.
- Lost or abandoned fishing traps were mapped and their impact on reef fishes was studied.

National Undersea Research Program

In response to Congressional interest and appropriations for the development of an expanded National Undersea Research Program, NOAA initiated the Caribbean Undersea Research Program in 1977. The seafloor habitat HYDROLAB was the focal point of the program, which was operated for NOAA by the West Indies Laboratory of Fairleigh Dickinson University. In the period 1978-81, a total of 41 HYDROLAB-based missions were conducted under the aegis of the OUR program.

The success of the Caribbean program and the demand for additional programs led, in 1980, to the signing of cooperative agreements between NOAA and the University of Hawaii, the University of Southern California, and the University of North Carolina at Wilmington. A fifth undersea research program was initiated in 1983 with the University of Connecticut at Avery Point. The activities, facilities, and achievements of these programs are described in greater detail in Section II, NOAA's National Undersea Research Program.

Other OUR Activities

In 1980-81, a variety of technology transfer, international, and interagency programs were sponsored or directly carried out by the Office of Undersea Research. For example, OUR supported the establishment of the Diving Accident Network (DAN), a 24-hour emergency medical consultation service designed to treat sport and professional divers suffering from pressure-related injuries, and contracted with the Undersea Medical Society for a series of workshops and publications on diving safety and underwater physiology and medicine. The program funded the Naval Medical Research Institute and the University of Maryland investigation of the microbial hazards associated with diving in polluted waters. Field tests of shallow-water saturation diving protocols developed by researchers were also conducted during 1981. Many of these programs have continued to receive support from the Office of Undersea Research and are described in the sections of this report that follow.

SECTION II

NOAA's NATIONAL UNDERSEA RESEARCH PROGRAM

HISTORY

The responsibility for developing programs for the assessment, protection, development, and utilization of the U.S.'s coastal zone resources was given to NOAA at the time the agency was established. NOAA's Undersea Research Program was initiated in 1977 to provide manned underwater facilities and other research support for scientific investigations of coastal marine environments and for research into underwater biological, geological, and ecological problems.

Under the program, the first regional underwater research facility was established in St. Croix, Virgin Islands, in 1977. The habitat, HYDROLAB, which had been newly refurbished and purchased by NOAA, was the focal point of the Caribbean program. A review in 1978 of the needs of the undersea research community indicated that the usefulness of NOAA's program would be increased if several undersea research facilities, each located in a scientifically important geographic area, were established. Placing undersea laboratories at scientifically strategic locations permits scientists to take advantage of local personnel and research resources and to develop a better understanding of all of the Nation's coastal zone areas.

To assess the merits of various geographical areas and the ability of institutions to operate a national program, NOAA informed more than 400 academic institutions of its plans to develop and maintain national undersea laboratories. Of the 15 organizations responding, 9 were selected and asked to submit detailed feasibility studies. These studies were thoroughly evaluated by a panel of scientists and engineers familiar with the needs of undersea research and with NOAA's goals and priorities.

The University of Hawaii, the University of Southern California, and the University of North Carolina at Wilmington were chosen to submit formal proposals and became the sites for the second, third, and fourth components of NOAA's national undersea research program. In 1980, NOAA signed cooperative agreements with each of these institutions, thus formally initiating the National Oceanic and Atmospheric Administration's National Undersea Research Program.

In 1982-83, plans were initiated to develop a fifth regional facility off the northeastern coast of the United States. Headquarters for the new undersea research program are located at the University of Connecticut at Avery Point. Figure II-1 shows the locations of NOAA's existing undersea research program headquarters.

NOAA's National Undersea Research Program at Fairleigh Dickinson University (St. Croix)

The first and most active component of NOAA's undersea research program was the Caribbean-based program operated by the West Indies Laboratory of Fairleigh Dickinson University. The focal point of the program has been and continues to be the habitat HYDROLAB, which is situated on the seafloor of the Salt River Canyon, off the north-central coast of St. Croix, U.S. Virgin Islands. Figures II-2A, B, C, and D show various views of the habitat.

In the first 3 years of the Caribbean program's operation, more than 40 science missions involving 500 days of saturation diving were conducted from the HYDROLAB facility. As tables II-1 and II-2 show, this level of activity continued during fiscal years 1982 and 1983. In FY 1982, 16 undersea research efforts involving scientist/aquanauts from 20 institutions, several disciplines, and 2 foreign countries (Kuwait and France) were carried out; and in FY 1983, a total of 13 HYDROLAB-based missions were conducted. The scientific purpose of these research projects ranged from studies of the life history and behavior of coral reef organisms to the chemical ecology and histocompatability of sponges to the development and testing of underwater fish marking and release techniques. Photographs taken during these HYDROLAB saturation dives are displayed in figures II-3A, B, C, and D. The results of several HYDROLAB missions have been published in the open literature or were reported on at the first annual symposium (see section IV).

Facilities

In 1977, the Ocean Agents Company refurbished the habitat for NOAA's use. Several views of the HYDROLAB in place on the Caribbean seafloor can be seen in figure II-2. This underwater platform is approximately 5 meters long and 2.5 meters in diame-

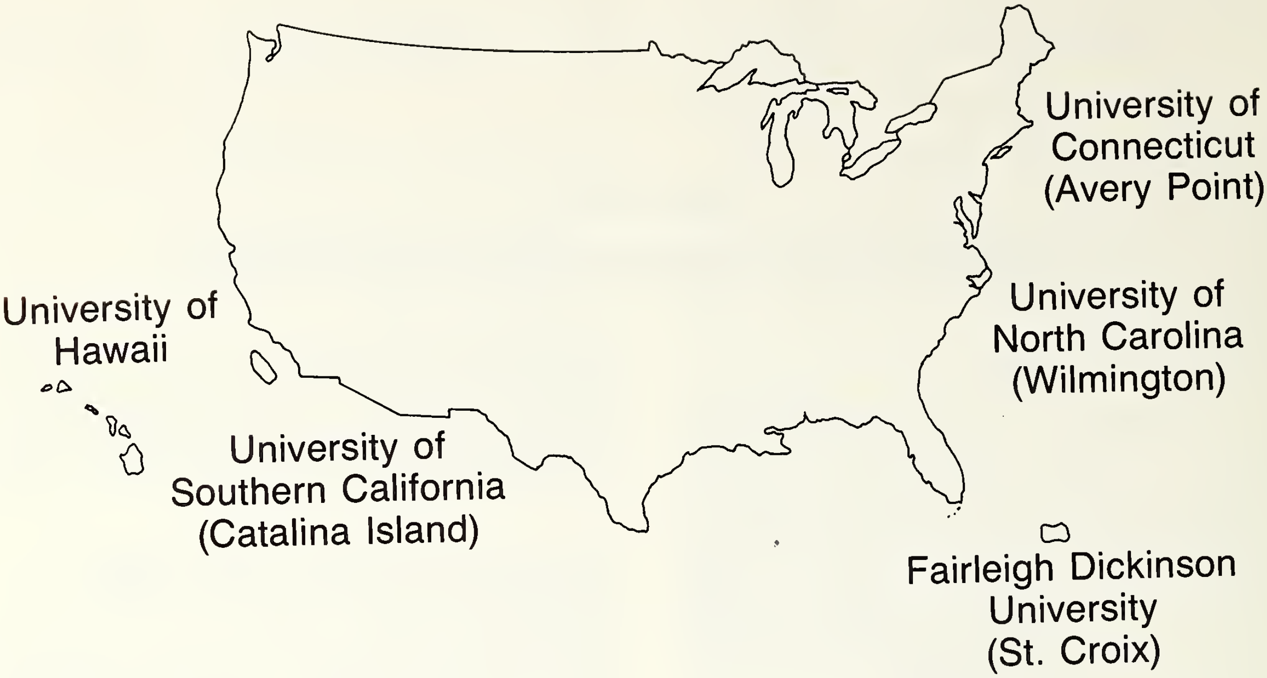

University of Connecticut (Avery Point)
University of North Carolina (Wilmington)
University of Hawaii
University of Southern California (Catalina Island)
Fairleigh Dickinson University (St. Croix)

Figure II-1.—Map showing locations of OUR's national undersea research laboratories.

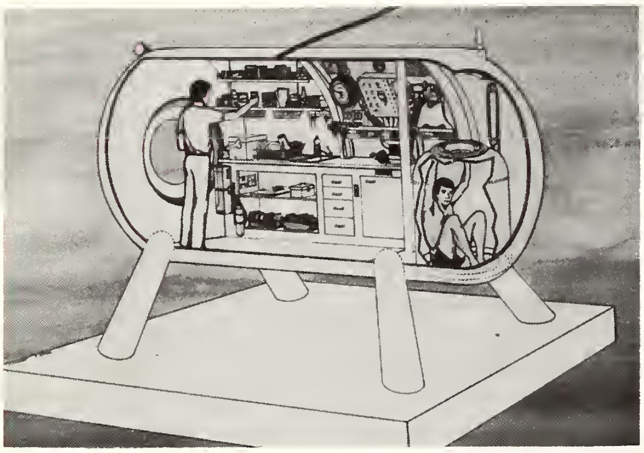


Figure II-2A.—Cutaway view of the habitat HYDROLAB.

ter. It has the capability to support four divers operating in the saturation mode for periods of 14 days.

The HYDROLAB is submerged at a depth of 15.2 meters, but excursion dives can be made to depths of 40 meters using the habitat as a base. The HYDROLAB has a double-lock entrance compartment and a 24-inch (diameter) entrance hatch. (Fig. II-4 shows a diver entering the habitat's hatch.) The facility has six external viewports, running water, electricity, heat, and three bunks for aquanaut/scientists. A diver support barge, shown in Figure II-5, supplies utilities to the habitat.

Figure II-2B.—Habitat HYDROLAB in place on the seafloor.

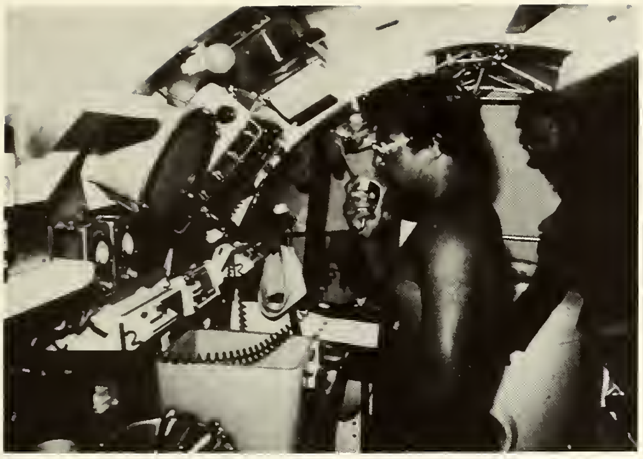


Figure II-2C.—Aquanaut/divers at work in HYDROLAB's laboratory.

Figure II-2D.—Divers in habitat watching colleague enter.

Table II-1.—FY 1982 NOAA's National Undersea Research Program Missions at Fairleigh Dickinson University (St. Croix)

Participating Institutions	Date of Mission and Purpose	Principal Investigator
West Indies Laboratory, Fairleigh Dickinson University	10/26/81—11/7/81 Competitive Behavior of Colonial Invertebrates	Thomas Suchanek
West Indies Laboratory, Fairleigh Dickinson University	11/16/81—11/28/81 Foraging Behavior of Rainbow Parrotfish	John Ogden
National Marine Fisheries Service, NOAA	12/7/81—12/18/81 Development and Testing of Underwater Fish Marking and Release Techniques	Gregg Gitschlag
University of Maryland; Cornell University; University of Georgia; University of Rochester	1/12/82—1/19/82 Analyses of Fish and Invertebrate Coral Reef Communities	Marjorie Reaka
University of Washington; Sarah Lawrence College; Cornell University; University of California	2/1/82—2/13/82 Ecology and Behavior of Caribbean Garden Eel	Myra J. Shulman; Raymond Clarke
California State University; Moss Landing Marine Laboratory	2/22/82—3/6/82 Planktivorous Fish as Nutrient Importers in Tropical Reef Communities	Richard Bray
Johns Hopkins University; University of Texas at Austin; University of Maryland; Smithsonian Institution	3/18/82—3/25/82 Control of Behavior in Colonial Animals	Charles Wahle; Elizabeth Chornesky
University of Puerto Rico; Auburn University	4/5/82—4/16/82 Experimental Transfer of the Isopod *Anilocra chromis* to the *Brown Chromis*	Ernest H. Williams, Jr.
University of Maine; University of Georgia	4/26/82—5/8/82 Role of Productivity and Herbivory in Structuring Tropical Algal Communities	Robert S. Steneck
University of Maryland; University of Georgia; University of Newcastle-upon-Tyne (United Kingdom)	5/17/82—5/29/82 Analysis of Ecological Processes that Structure Fish and Invertebrate Reef Communities	Marjorie Reaka

Table II-1.—Continued

Participating Institutions	Date of Mission and Purpose	Principal Investigator
U.S. Virgin Islands, Department of Conservation and Cultural Affairs	6/7/82—6/17/82 Relationship of Coral Recruitment and Grazing Intensity to Distribution of Algae and Corals	Caroline Rogers
Kuwait Institute for Scientific Research (Kuwait); West Indes Laboratory, Fairleigh Dickinson University	6/24/82—7/2/82 Movements of Grouper Fish in Relation to Artificial Reefs	Nigel Downing; Camille Al-Zehar
Utah State University; University of Michigan	7/12/82—7/24/82 Dynamics of Diel Migratory Activity of Reef-Dwelling Demersal Zooplankton	David Liddell; Sharon Ohlhorst
University of Rochester; University of Washington; Woods Hole Oceanographic Institution; Utah State University; U.S. Navy Oceanographic Office	8/2/82—8/14/82 Taphonomy and Environmental Indicators of Extant Reef Biota	Carlton Brett
University of New Hampshire; University of Georgia; University of Washington	8/23/82—9/4/82 Competition Among Encrusting Colonial Invertebrates in Open Reef Habitats	Thomas Suchanek
University of Hawaii at Manoa	9/13/82—9/25/82 Social Organization of Rock Beauty Angelfish	Ernest S. Reese

Table II-2.—FY 1983 NOAA's National Undersea Research Program Missions at Fairleigh Dickinson University (St. Croix)

Participating Institutions	Date of Mission and Purpose	Principal Investigator
University of Maryland; University of Georgia; University of Pennsylvania; Harvard University	1/10/83—1/22/83 Patterns of Life History and Behavior in Coral Reef Organisms	Marjorie Reaka
National Marine Fisheries Service, NOAA; Texas A&M University; Office of Marine Operations, NOAA	2/3/83—2/10/83 Attraction of Pelagic Fishes to Midwater Structures	Ian K. Workman
Skidaway Institute of Oceanography; University of Georgia	2/21/83—3/5/83 Chemical Ecology and Histocompatability of Sponges	Nancy M. Targett
University of Puerto Rico; Auburn University	3/14/83—3/26/83 Early Life History and Host Relationships of the Isopod *Anilocra chromis*	Ernest H. Williams, Jr.
State University of New York at Stony Brook; Fresno State University	4/4/83—4/16/83 Growth of *Caulerpa* spp. and Its Relationship to Sediment Habitat	Susan L. Williams
Marymount Palos Verdes College; University of Southern California	4/25/83—5/5/83 Influence of Fish Predators on Activity Patterns of *Diadema antillarum*	James A. Coyer
California State University at Long Beach	5/30/83—6/11/83 Planktivorous Fish as Nutrient Importers in Tropical Reef Communities	Richard Bray
San Francisco State University; Tiburon Center for Environmental Studies; National Marine Fisheries Service, NOAA	6/20/83—7/2/83 Ecological Function and Fishery Resources of *Halophila* Beds	Thomas Niesen

Table II-2.—Continued

Participating Institutions	Date of Mission and Purpose	Principal Investigator
University of Virginia	7/14/83—7/21/83 Assessment of Deep *Halophila* Seagrass Meadow as Fish Habitat and Feeding Ground	Michael Robblee; Carol McIvor
Kuwait Department of Mariculture and Fisheries (Kuwait); Fairleigh Dickinson University	7/8/83—7/21/83 Artificial Reef Utilization by Grouper Fish	Nigel Downing; Camille Al-Zehar
Florida State University; University of Puerto Rico	7/29/83—8/15/83 Role of Herbivorous Fish in Nitrogenous Regeneration on Coral Reefs	Alina Szmant-Froelich
Laboratoire de Biologie et D'Ecologie Marines (France)	9/12/83—9/22/83 Morphological Variation of *Caulerpa;* Study of Macrobenthic Species on the Shelf Bottom	Claude Falconetti
Universite de Liege (Belgium)	9/12/83—9/22/83 Sociobiology and Sex Change of Labroid Fishes	Daniel Bay

Like all NOAA undersea research vessels, the HYDROLAB is certified by the American Bureau of Shipping (ABS). All research personnel involved in HYDROLAB projects undergo thorough training and certification programs before participating in NOAA-sponsored missions. The success of NOAA's underwater safety program is attested to by the outstanding record of safety of the HYDROLAB program, which has logged more than 70 undersea research missions without a single serious mishap.

NOAA's National Undersea Research Program at the University of Hawaii

The University of Hawaii is the base for NOAA's Hawaiian Undersea Research Program component. The program headquarters is located at the Makai Research Pier at Makapuu Point, on the island of Oahu. The program relies on the two-man research submersible MAKALI'I and the Launch, Recovery, and Transport (LRT) vehicle HIILAWE (see fig. II-6).

Research areas emphasized by the program include:

- Fisheries: ecosystem assessment and dynamics; habitat degradation and enhancement; harvesting impact; animal behavior; and gear development
- Pollution: manner and physical effects of waste disposal; behavioral, biochemical, and physiological responses of marine organisms to pollutants
- Seafloor properties and processes: geological, geochemical, and geophysical aspects, including gradients in the water column near the seafloor, sediment transport, stability, fluxes, and mineral resources
- Ocean technology and services: marine sanctuary monitoring; engineering; equipment testing and recovery; medical and diving physiology; and archaeology

The program peer review panel reviews research proposals submitted on these and other areas of scientific importance and recommends to the program those judged as having the greatest scientific merit, cost-effectiveness, and suitability in relation to NOAA's overall program.

Facilities

The principal research vessel used in the Hawaiian program is the one-atmosphere submersible MAKALI'I (fig. II-7). This submersible has a depth capability of 380 meters and an operating speed of from 1 to 3 knots. It has been certified as an A-1 submersible by the ABS, after an extensive period during which it underwent disassembly and refurbishing. The ABS test dive of the newly modified submersible took place July 15, 1981. The MAKALI'I can accommodate a pilot, a scientist/observer, and a 200-pound payload.

The Launch, Recovery, and Transport (LRT) vehicle HIILAWE was designed to transport, launch, and recover the MAKALI'I. SCUBA divers aboard the HIILAWE control the vehicle as it is towed, carrying the MAKALI'I (fig. II-8) to the launch site. Once the

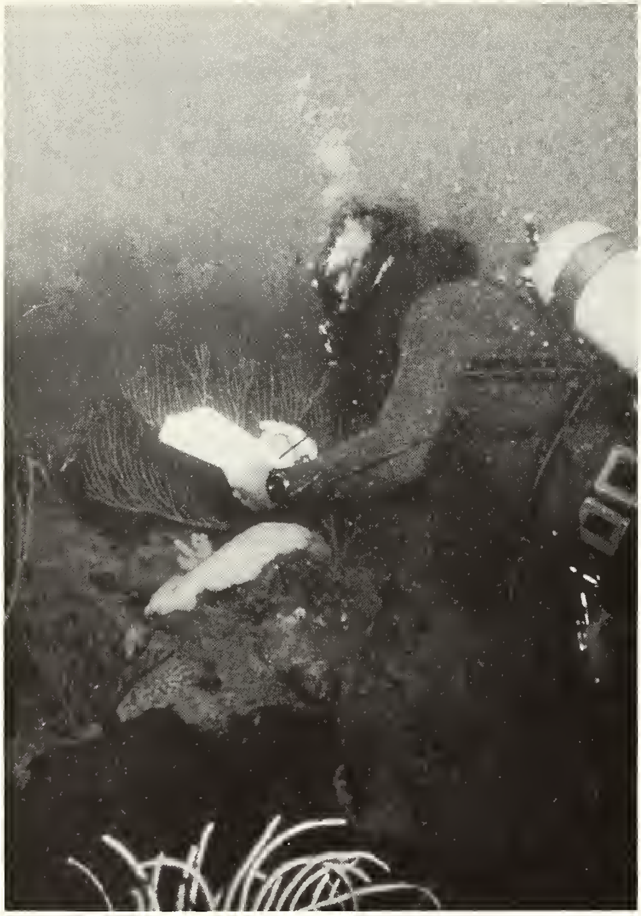


Figure II-3A.—HYDROLAB scientist reviewing notes.

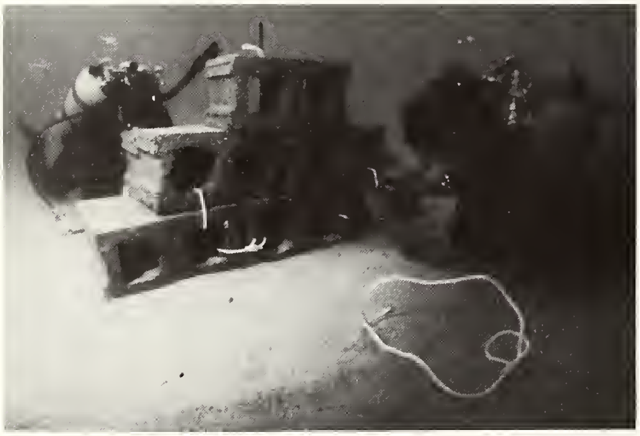


Figure II-3B.—Artificial reef emplaced by NOAA aquanaut/scientists.

proper launch position has been reached, the LRT vehicle submerges to enable the submersible to be launched (or retrieved) in the sub-surface water layer, which is considerably calmer than the surface layer.

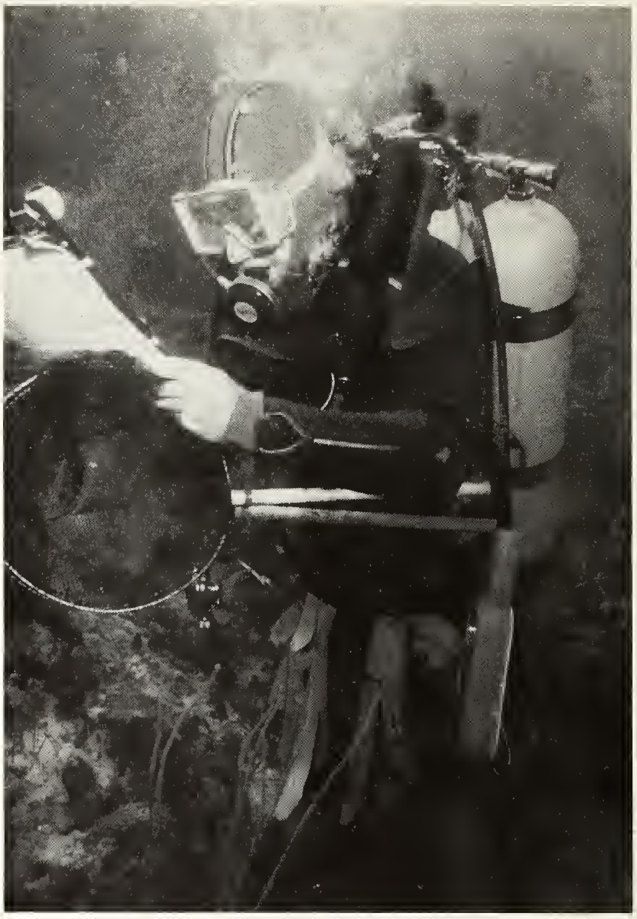


Figure II-3C.—Working aquanaut/scientist on Caribbean mission.

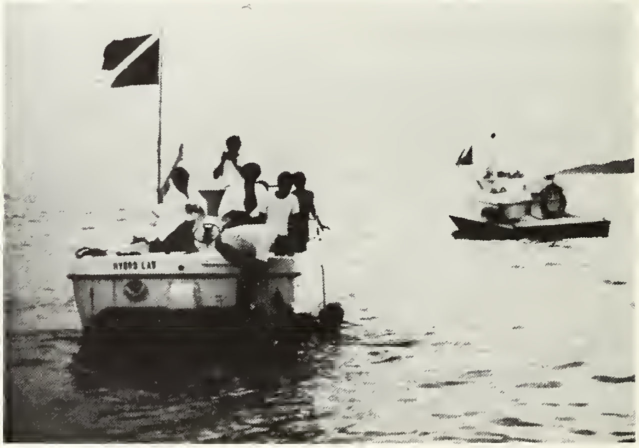


Figure II-3D.—Support crew assisting HYDROLAB divers.

In FY 1982, the recompression chamber located at headquarters was refurbished to meet the NOAA Diving Safety Board's requirements for on-site hyperbaric treatment facilities. The chamber is presently in use

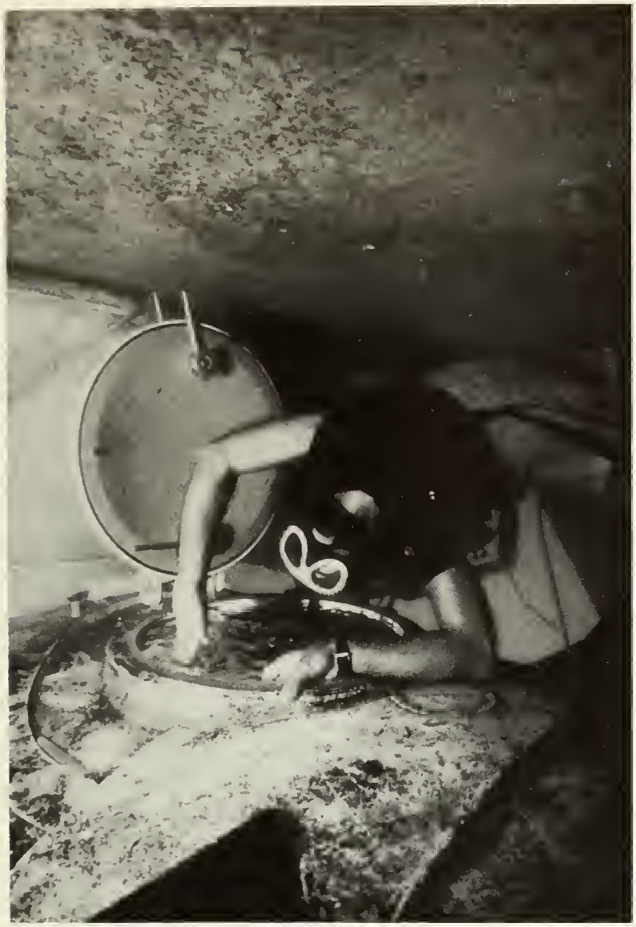


Figure II-4.—Diver entering HYDROLAB hatch.

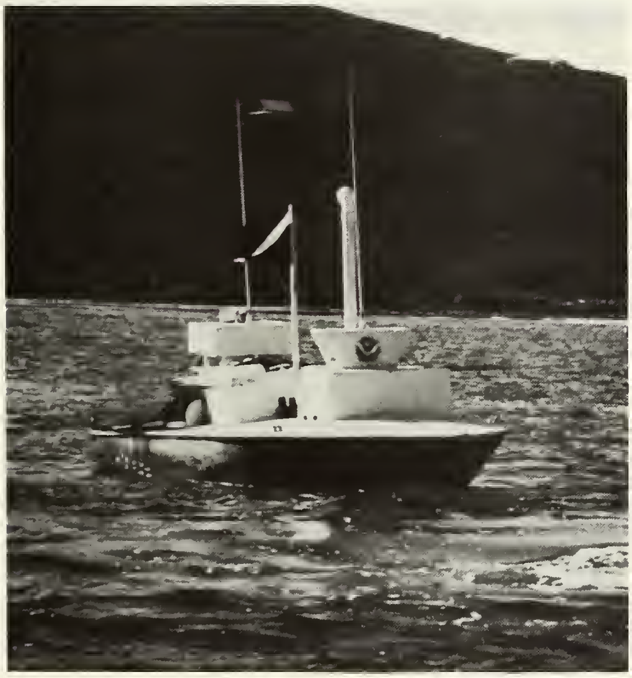


Figure II-5.—Diver support barge for HYDROLAB habitat.

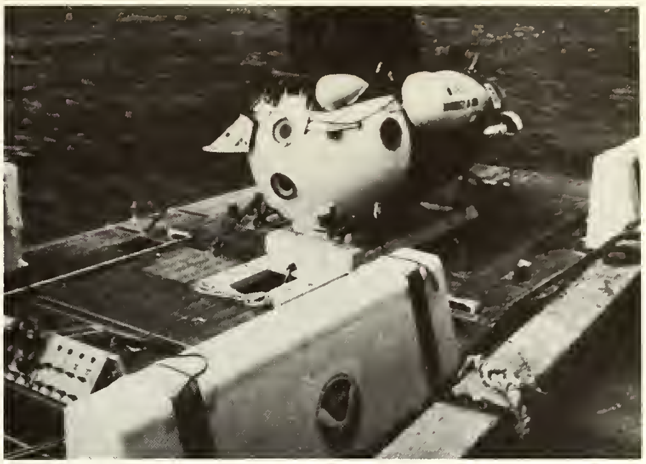


Figure II-6.—The Hawaiian program's HIILAWE and MAKALI'I.

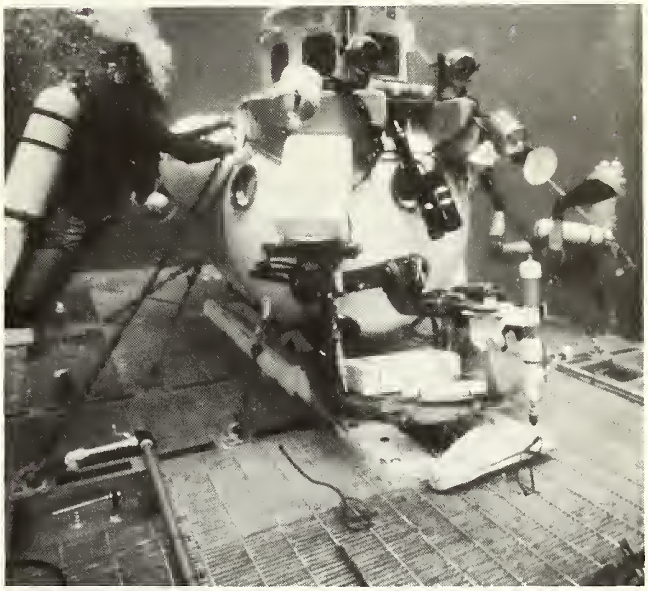


Figure II-7.—The Hawaiian program's submersible MAKALI'I.

for both decompression and recompression of program personnel. Since 1981, more than 200 dives have been performed. Figures II-9 and II-10 show scientists involved in underwater tasks. Summary information on these missions is presented in tables II-3 and II-4.

The program's major project for 1984 is the Johnston Atoll Research Project, designed to use the MAKALI'I in a series of dives to explore the environmental feasibility of disposing of scrubber brine waste generated by the Army's Johnston Atoll Chemical Agent Disposal System. The outcome of this joint Army-NOAA research effort will be described in the Office of Undersea Research's 1984 Annual Report.

The program also operates the remotely operated vehicle (ROV) SNOOPY, a small ROV equipped with real-time viewing capability. The ROV uses a black-and-white video camera or a super-8mm movie camera to photograph undersea research subjects at depths as great as 1,200 feet of seawater. Figure II-11 is a photograph of SNOOPY on a research mission.

Plans are underway to refurbish the underwater habitat AEGIR, last operational on a limited basis in 1975.

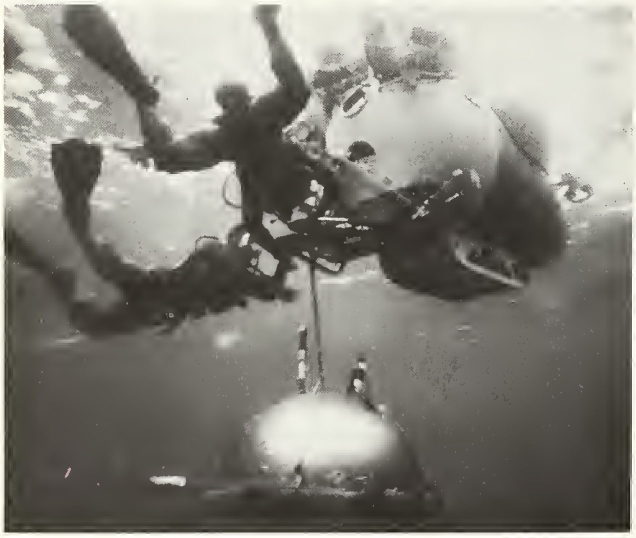


Figure II-8.—Divers towing the submersible MAKALI'I.

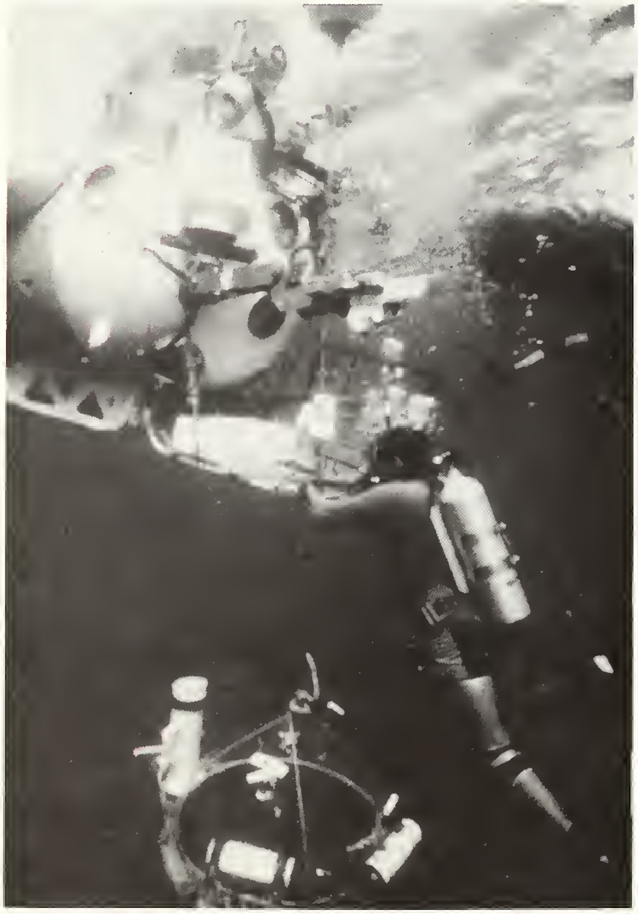


Figure II-9.—Submersible MAKALI'I deploying bubble way-station.

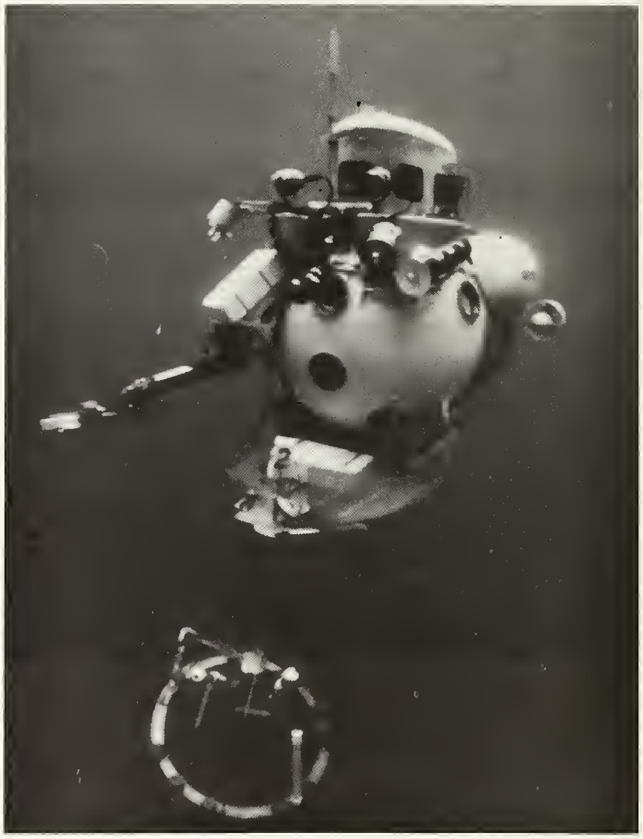


Figure II-10.—Submersible deploying experimental dome.

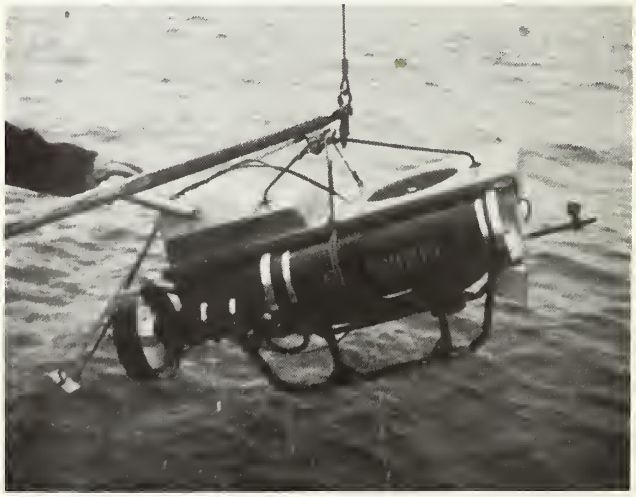


Figure II-11.—Remotely operated vehicle SNOOPY.

Table II-3.—FY 1982 NOAA's National Undersea Research Program Missions at University of Hawaii

Participating Institutions	Date of Mission and Purpose	Principal Investigator
University of Hawaii	12/15/81; 12/16/81 Antimicrobial Activity of Harvested Gorgonians	David Klein; Robin Kinnel
U.S. Army Corps of Engineers; University of Hawaii; Hawaii Institute of Marine Biology	4/21/82; 4/23/82; 5/3/82 Long-Term Impacts of Deep Ocean Disposal of Dredged Materials in Hawaii	James Maragos; Edith Chave; Steven Dollar
National Marine Fisheries Service (NOAA)	5/17/82; 5/19/82; 5/28/82; 5/31/82; 6/2/82; 6/4/82; 9/13/82 Composition, Distribution, and Abundance of Bottom Fishes	Reginald Gooding; Stephen Ralston
Hawaiian Electric Company	5/3/82; 5/7/82 Cable/Pipeline Routing Reconnaissance	Stephen L. Coles
Hawaii Institute of Marine Biology	3/29/82; 4/29/82 Response of Benthic Ecosystem to Sand Island Sewage Outfall	Steven Dollar
University of Hawaii	5/24/82; 6/14/82 Natural Products Chemistry of Benthic Invertebrates	Paul Scheuer
Bishop Museum	6/7/82 Collection of Benthic Invertebrates and Fishes	Dennis Devaney
University of Hawaii	6/9/82 Deep Sea Corals	Paul Scheuer; Michael Li
University of Hawaii	6/10/82; 6/11/82 Chemical Investigation of Deepwater Hawaiian Gorgonians	Paul Scheuer; Robin Kinnel; Edith Chave
U.S. Army Corps of Engineers; Bishop Museum	8/31/82 Survey of Benthic Fauna	James Maragos; Arnold Suzumoto; Dennis Devaney
University of Hawaii; Bishop Museum	9/1/82 Pearl Harbor Dredge Spoil Site Investigation	Edith Chave; Dennis Devaney
National Marine Fisheries Service (NOAA); University of Hawaii	9/7/82; 9/15/82; 9/17/82; 9/20/82 Bathymetric Distribution of Bottomfishes and Role of Algae Communities as Nursery Grounds	Stephen Ralston; Catherine Agegian
U.S. Army Corps of Engineers; University of Hawaii	9/10/82 Assessment of Fauna and Dredge Spoils in an Outcrop at Mamala Bay	James Maragos; Edith Chave

Table II-4.—FY 1983 NOAA's National Undersea Research Program Missions at University of Hawaii

Participating Institutions	Date of Mission and Purpose	Principal Investigator
University of Hawaii	10/1/82; 10/2/82; 10/4/82; 10/6/82; 10/8/82; 10/13/82 Hydrothermal Vents on Rift Zone (Puna Rift)	Gary McMurtry; David Foster; David Epp; Kim Orrett; David Karl

Table II-4.—Continued

Participating Institutions	Date of Mission and Purpose	Principal Investigator
U.S. Army Corps of Engineers; University of Hawaii; Bishop Museum	10/15/82; 10/17/82; 10/29/82; 10/31/82; 11/2/82; 12/22/82 Assessment of Deep-water Dredge Spoil Impacts on Flora and Fauna	James Maragos; Edith Chave; Dennis Devaney
Natural Energy Laboratory; Makai Ocean Engineering	10/19/82; 10/20/82; 10/23/82 Bottom Survey, Keahole Point	T. Daniel; J. Van Ryzin
University of Hawaii	15 missions between 12/13/82 and 1/31/83 Response of Benthic Ecosystem to Sand Island Sewage Outfall	Steven Dollar
University of Hawaii	12/20/82 Transponder Testing	J. P. Craven; Edith Chave
University of Hawaii	2/14/83 Secondary Metabolites of Deep Sea Invertebrates	Paul Scheuer
University of Hawaii; University of North Carolina	2/16/83 Substrate Study of Slope	Keith Chave
University of Hawaii	2/19/83 Chemical Studies of Deep Sea Corals	Paul Scheuer
University of Hawaii; Bishop Museum	2/22/83 Natural Products Chemistry, Collection of Organisms	Paul Scheuer
University of Hawaii	2/24/83 Ancient Shorelines, Flashlight Fishes, Deep Fisheries Resources	Edith Chave
University of Hawaii	3/1/83 Investigations of Communities on Hard Substrates	Keith Chave
University of Hawaii	3/3/83 Chemical Constituents of Deep Sea Animals	Paul Scheuer
University of Hawaii; Stanford University; Harvard University	3/7/83; 3/28/83 Hard Rock Communities	Keith Chave
University of Hawaii; Hawaii Institute of Marine Biology	3/11/83 Marine Pharmaceuticals	Paul Scheuer
University of Hawaii	4/7/83 Science Training Dive	J. P. Craven
University of Hawaii; California Academy of Sciences	4/12/83 Flashlight Fishes and Deep Sea Resources	Edith Chave
U.S. Army Corps of Engineers; University of Hawaii	4/22/83; 4/26/83; 4/28/83 4/30/83; 5/2/83 Assessment of Deep Water Dredge Spoil Disposal in Hawaii	James Maragos
U.S. Geological Survey; Lamont-Doherty Geological Observatory	6/5/83; 6/7/83; 6/9/83; 6/11/83; 6/13/83; 6/17/83; 6/20/83; 6/22/83 Bottom Geology of Kealakekua Bay	James Moore; Daniel Fornari; David Clague
University of Hawaii	6/26/83 Kona Fishery Resources and Camera Testing	Edith Chave
National Marine Fisheries Service (NOAA); U.S. Fish and Wildlife Service	9/24/83; 9/25/83; 9/26/83; 9/28/83; 9/30/83 Fisheries Investigations of Johnston Atoll	Richard Shomura; Gerald Ludwig; Reginald Gooding; Stephen Ralston

The AEGIR is a simple, spacious, and easily moved habitat (fig. II-12). It contains living quarters for six scientist/aquanauts, a control center, and a galley and working space. The work area has laboratory facilities and storage space for scientific instruments and equipment. AEGIR's depth capability is approximately 177 meters, although it will not be used at depths greater than 60 meters in OUR's program. When AEGIR becomes operational, the Hawaiian program will have a full complement of undersea research facilities: a habitat, submersible, LRT, support vessels, and an ROV. This range in facilities will permit the program to undertake undersea research projects in several scientific areas.

NOAA's National Undersea Research Program at University of Southern California

The third link in NOAA's cooperative undersea research program is NOAA's Undersea Research Program on Santa Catalina Island, 25 miles offshore from Los Angeles, California. The program is directed by the University of Southern California (USC) and is headquartered at USC's Catalina Marine Science Center (fig. II-13).

Facilities

The facilities and program offer a unique opportunity for marine scientists from a variety of disciplines to conduct research in temperate waters using saturation diving techniques. Santa Catalina Island has established transportation, communication, and emergency facilities, and the Marine Science Center complex includes laboratories, a dormitory-apartment-cafeteria complex, administration buildings, a pier and dock, a day-night helioport, and a dual-lock multiplace hyperbaric chamber.

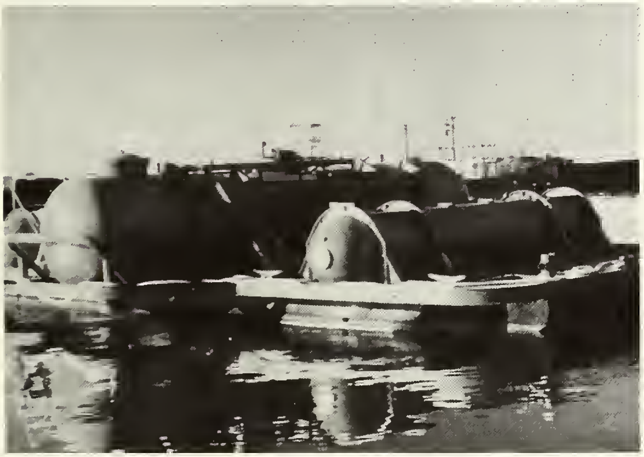


Figure II-12.—Habitat AEGIR, being refurbished for use in the Hawaiian program.

The principal attraction of the program will be the saturation habitat system (see fig. II-14), which will be operational in 1986. The detailed design phase for the habitat was completed in May 1982, with additional minor modifications implemented since then. The seafloor habitat has been designed with five principal factors in mind:

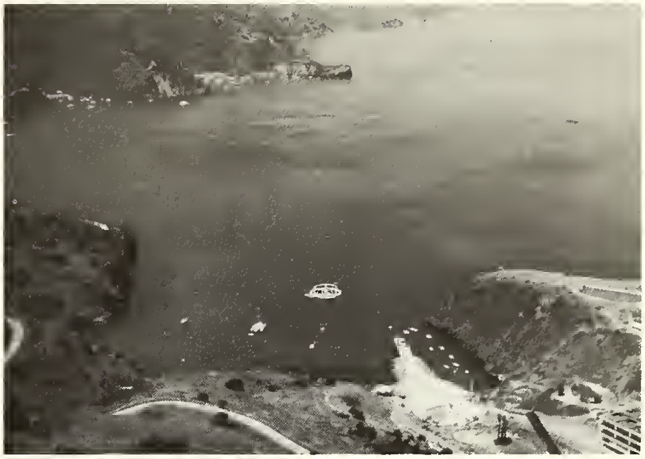


Figure II-13.—Site of NOAA's National Undersea Research Program at University of Southern California on Catalina Island.

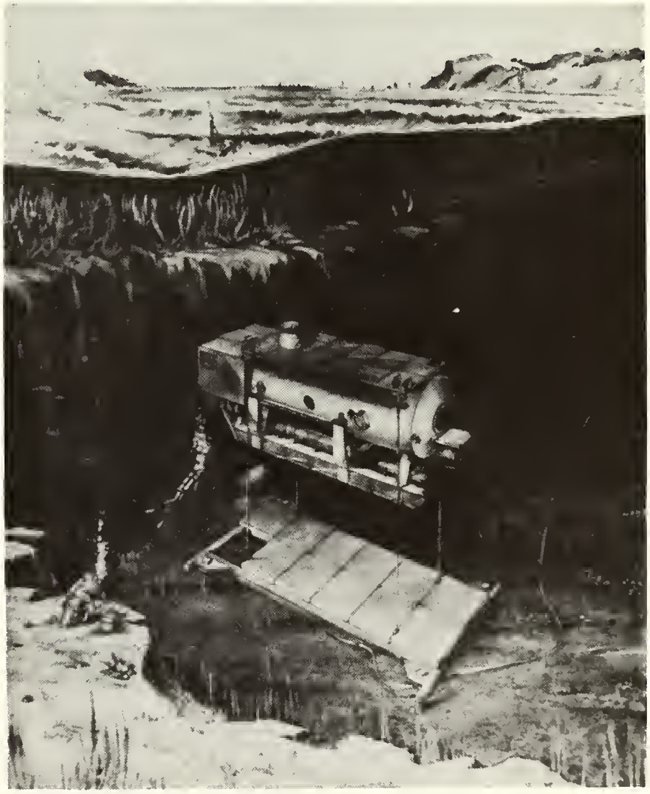


Figure II-14.—Artist's conceptualization of USC habitat.

- Safety (ABS certification)
- Cost-effectiveness
- Operational simplicity
- Versatility
- Maximum utilization of available facilities

The basic habitat will have a double-lock chamber capable of both bottom and surface decompression and will have the ability to be towed to another location without major modification of the structure. It will operate independently of shore support, with life-support functions supplied by a life support barge overhead. The habitat will be anchored by a movable and negatively buoyant base plate implanted on the seafloor at the research site. Control of all habitat functions will be in the hands of habitat occupants.

Diver/scientists will breathe a mixture of nitrogen-oxygen called NITROX, which will permit them to make excursion dives to depths of approximately 200 fsw from the habitat's storage depth of 60-120 fsw. Divers will swim to the seafloor habitat from the surface, except under emergency conditions, when a Personnel Transfer Capsule (PTC) with on-board treatment capability will be used instead. Decompression sickness treatment will be available in the habitat as well.

At the entrance to the habitat system is a "wet porch," a sheltered area providing access to the sea and containing a sorting tray for collected specimens. The wet porch area also is equipped with a rewarming tub, to be used in cases of hypothermia.

The habitat's main compartment will have sleeping and galley accommodations for as many as six scientist/aquanauts. Shower and bathroom facilities are located in the entrance compartment. Laboratory facilities include a dry laboratory with microscopes, dissection equipment, and computer equipment that will permit real-time data analysis. The computer will be used to catalog samples and specimens and to plot trend graphs, as well as to monitor internal habitat conditions such as temperature and humidity.

The range of habitat diver/scientists will be extended by the use of underwater way-stations, which are open diving bells equipped with communications, breathing gas supplies, and electrical power. The way-station consists of a heavy metal base with a plastic dome or "bubble" mounted above the base on metal struts. The bubble is filled with NITROX via a umbilical from the habitat. The program anticipates that the habitat will be headquarters for 12-16 saturation research missions per year, each having a duration of a week to 10 days.

Interim Undersea Science Program

In the period before the saturation habitat system becomes operational, the interim program will be initiated. Under this program, scientists are utilizing SCUBA, surface-supplied air and mixed-gas diving, and the open diving bell way-station described above to conduct marine research projects in California's temperate waters. Figure II-15 shows a diver being dressed for a surface-supported dive. Research opportunities include investigations of midwater, sand, muck, and rocky substrates, cliffs and coves, and lush beds of large algae such as giant kelp (*Macrocystis pyrifera*) and elk kelp (*Pelagophycus porra*) (fig. II-16). Missions conducted under the interim program are limited to depths of 130 fsw and periods of less than 14 days.

NOAA's National Undersea Research Program at University of North Carolina-Wilmington

Established in 1980 under a cooperative agreement signed by NOAA, NOAA's Undersea Research Program at University of North Carolina-Wilmington forms the fourth element in NOAA's national undersea laboratory program. The consortium that adminis-

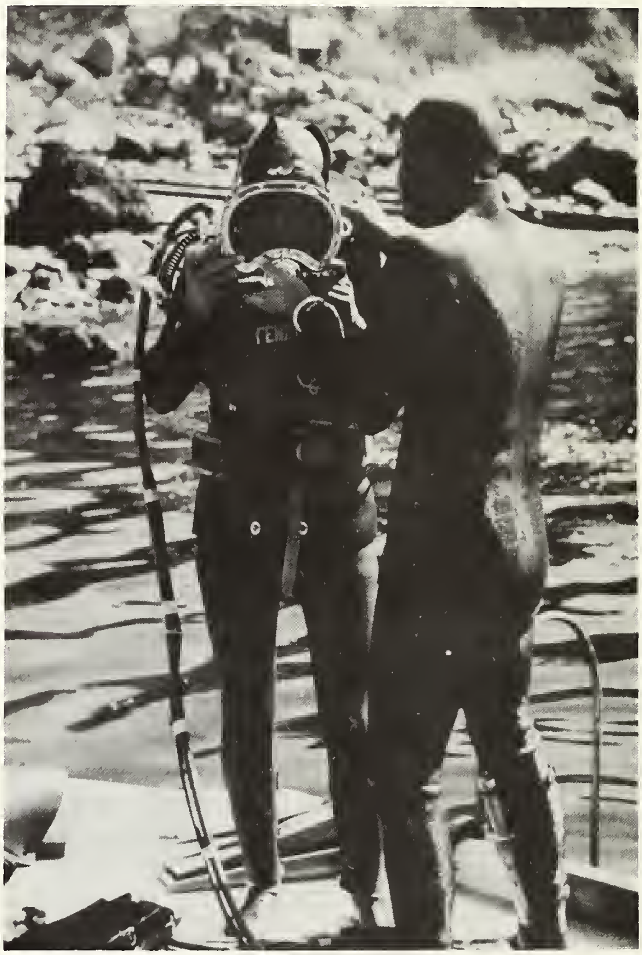


Figure II-15.—Surface-supplied diver in USC's interim science program.

Figure II-16.—Kelp beds offshore from Catalina Island.

ters the program is composed of academic institutions, research organizations, and government agencies from Virginia, North Carolina, South Carolina, and Georgia. Research projects focus on marine fisheries, seafloor processes, petroleum pollution, ocean dumping effects, dredge spoil disposal, and diving medicine and safety.

Facilities

In 1981, UNC-W's 70-foot long shrimp trawler LADY ELLEN was converted into the modern, well-equipped, and versatile RESEARCH VESSEL (R/V) SEAHAWK (fig. II-17). The R/V SEAHAWK is equipped and certified for SCUBA, surface-supplied air or mixed-gas diving, and bell diving to depths of 250 fsw. The vessel is fitted with a deck decompression chamber, berthing arrangements for 12 persons (8 crew and 4 scientist/aquanauts), a refrigerated specimen storage area, and a laboratory complete with running water, working space, and electricity. An interior view of the SEAHAWK's recompression chamber is shown in fig. II-18.

The R/V SEAHAWK's first sea voyage took place in July 1982 and involved a research study of the stromatolite formations off Key Largo and other northern keys to determine the distribution of these reef-building algae in these regions. All of the SEAHAWK's systems worked perfectly during her maiden voyage. Research projects carried out by UNC-W staff and visiting scientist/aquanauts aboard the SEAHAWK in FY 1982 are shown in table II-5, and FY 1983 missions are presented in table II-6.

Scientist/divers on missions make use of an open bell that provides an underwater refuge, and they use both the SCUBA and surface-supplied diving modes (see figs. II-19A, B, and C). Divers are tended from the small boat ZODIAK, which is carried aboard the SEAHAWK when not in use. In 1983, the diving system was upgraded to include mixed-gas diving capability, which will permit research to be conducted to depths of 300 fsw.

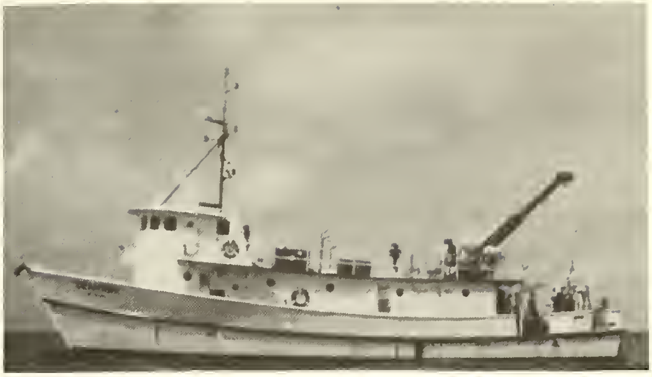


Figure II-17.—Research Vessel SEAHAWK, used in NOAA's UNC program.

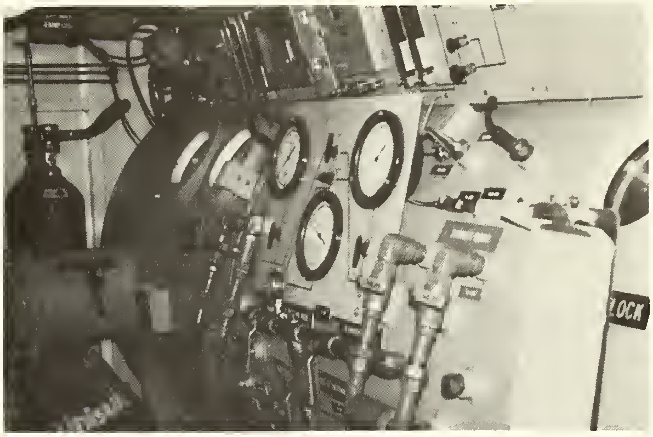


Figure II-18.—Interior view, deck decompression chamber on board the R/V SEAHAWK.

Research

The geographical region encompassed by the program covers thousands of square miles stretching from the Gulf of Maine to the Gulf of Mexico. Fishery habitats, sandy bottoms, and hard-bottom faunal communities are characteristic of this area (see fig. II-20). The principal research topics of interest are:

- Environmental impacts of marine pollution and waste disposal programs
- Fisheries management
- Hyperbaric physiology and diving medicine
- Marine archaeology
- Baseline data on undersea geology, plant and animal life, and seafloor processes.

The program plans to phase in additional facilities to expand the scope and range of its research activities.

Table II-5.—FY 1982 NOAA's National Undersea Research Program Missions at University of North Carolina-Wilmington

Participating Institutions	Date of Mission and Purpose	Principal Investigator
Virginia Polytechnic Institute and State University	7/23/82—7/27/82 Biogeological Investigation of Stromatolites of Two Eastern Continental Shelf Areas	George M. Simmons, Jr.
National Marine Fisheries Service (NOAA)	7/29/82—8/19/82 Ecological Effects of Energy Development on Reef Fish and Benthos Populations at Flower Garden Banks, Gulf of Mexico	Gregg Gitschlag
University of North Carolina	9/24/82—9/25/82 Primary Production and Grazing of Soft-Bottom Microflora	Lawrence Cahoon

Table II-6.—FY 1983 NOAA's National Undersea Research Program Missions at University of North Carolina-Wilmington

Participating Institutions	Date of Mission and Purpose	Principal Investigator
Virginia Institute of Marine Science	10/5/82—10/6/82 Sediment Disturbance and Transport by Waves and Currents on the Shallow Continental Shelf	Robert Byrne
Virginia Institute of Marine Science	10/15/82 Recolonization of *in-situ* Defaunated Sediments and Various Dredged Materials at an Ocean Disposal Site	Robert Diaz
North Carolina Division of Marine Fisheries	11/1/82—11/2/82 Species Utilization of Various Reef Configurations and Spacing	James T. Brown; James Tyler
University of North Carolina	11/8/82 Quantitative Evaluation of Photographic Records to Determine Fish Populations at Reefs and to Assess Size and Composition of Commercial Bottom Fishes	Randall Lennon
Virginia Institute of Marine Science	11/14/82—11/17/82 Recovery of Acoustical Recall Devices	Robert Byrne
University of North Carolina	12/15/82 Sampling of Epibenthic Layer for Particulate Organic Carbon and Chlorophyll	Lawrence Cahoon
University of Georgia; University of California	2/22/83—3/4/83 Assess Depth-Related Trends in Near-Shore Primary Productivity of Benthic Reef Corals	James Parker; Leonard Muscatine
Virginia Institute of Marine Science	3/28/83—4/1/83 Establish Stations at Various Depths and Obtain Baseline Data	Richard Byrne; Robert Diaz
University of North Carolina	5/4/83—5/5/83 Quantification of Near-Bottom and Benthic Organisms at Base of Coastal Marine Food Chain	Lawrence Cahoon

Table II-6.—Continued

Participating Institutions	Date of Mission and Purpose	Principal Investigator
Virginia Institute of Marine Science	5/17/83—5/24/83 Characteristics and Consequences of Benthic Boundary Layers in Different Environmental Conditions	James Byrne; Robert Diaz
University of North Carolina	6/6/83—6/9/83 Study of Near-Bottom Microalgae/ Biomass Maxima	Lawrence Cahoon
Virginia Polytechnic Institute and State University	6/13/83—6/17/83 Locate Stromatolites and Benthic Algae Mats in Onslow Bay	George Simmons
University of Southern Florida	6/22/83—6/27/83 *In-Situ* Testing of Sediment Erosion Evaluation Instrument, SEAFLUME	Giselher Gust
Duke University; Trinity College	8/5/83—8/10/83 Bathymetric Distributions of Seaweeds Around Bermuda	Richard Searles; Craig Schneider
Virginia Institute of Marine Science	8/16/83—8/18/83; 9/19/83—9/26/83 Characterization of Bottom Roughness Features and Observation of Near-Bottom Flow Field	Richard Byrne
University of North Carolina	8/24/83—8/27/83 Sample Demersal Zooplankton During Day and Nighttime	Lawrence Cahoon

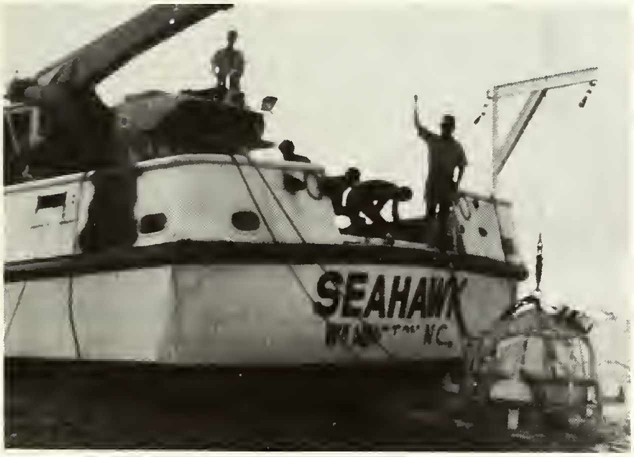


Figure II-19A.—R/V SEAHAWK lowering open bell for scientist divers.

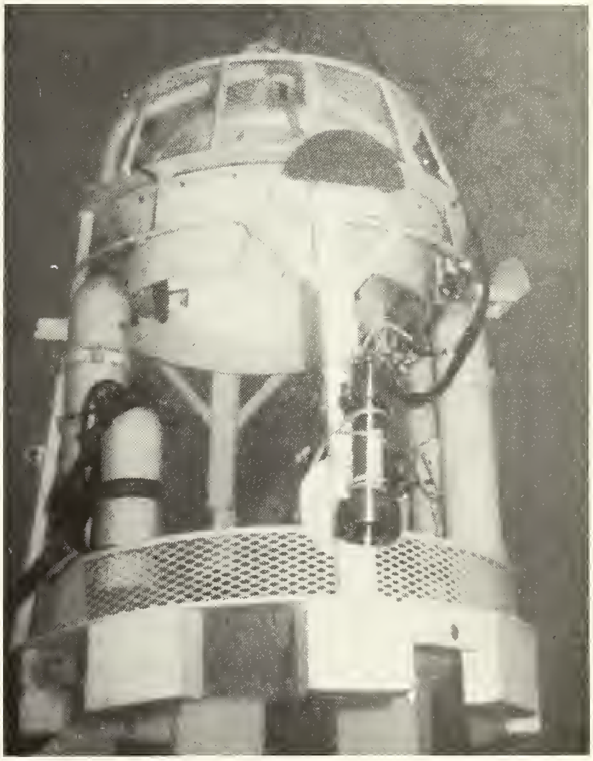


Figure II-19B.—Open bell used by UNC scientists.

Figure II-19C.—Preparing an aquanaut/diver for a science mission.

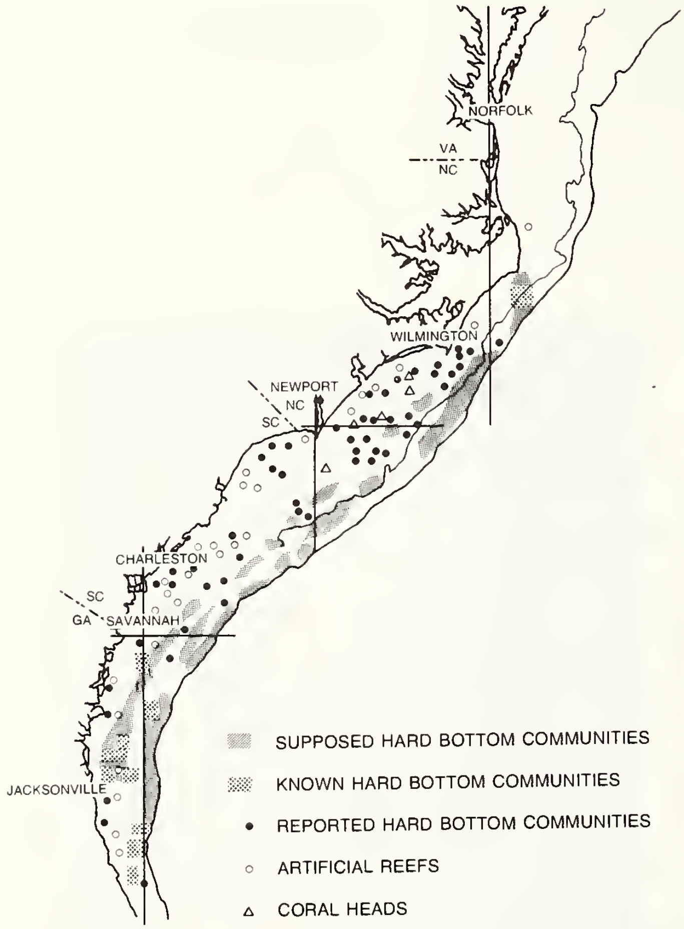

NORFOLK
VA
NC
WILMINGTON
NEWPORT
NC
SC
CHARLESTON
SC
GA
SAVANNAH
JACKSONVILLE
▨ SUPPOSED HARD BOTTOM COMMUNITIES
▨ KNOWN HARD BOTTOM COMMUNITIES
● REPORTED HARD BOTTOM COMMUNITIES
○ ARTIFICIAL REEFS
△ CORAL HEADS

Figure II-20.—Map of the geographical area covered by the UNC program.

A new support vessel, closed diving bell, and a research submersible may be added in the near future.

NOAA's National Undersea Research Program at University of Connecticut

In late 1983, NOAA's Office of Undersea Research joined the University of Connecticut in a cooperative agreement to establish NOAA's undersea research program at University of Connecticut in the northeast region of the United States. The headquarters for the new program will be at the university's facilities at Avery Point, Connecticut. This program becomes the fifth component of NOAA's National Undersea Research Program (see fig. II-21) and is designed to serve the marine research needs of the scientific community from the northeast region of the country.

The program's first activity was the establishment of an Advisory Board composed of scientists from the major marine institutions in the northeast region. Three subcommittees of the Board were formed: the Priorities/Planning, Technology Evaluation/Development, and Proposal Review subcommittees. Three seminars were held in Rhode Island, New Hampshire, and Maine to introduce the scientific communities in those areas to the goals, plans, and priorities of the Northeast Undersea Research Program. Scientific response to these seminars was substantial: 28 proposals for research projects were initially submitted to the Science Director.

Review of these proposals has identified several major themes for undersea research in the geographical area served by the new regional program. The major northeast coast priority is gathering information on living resources and their habitats, which is of great impor-

Figure II-21.—Headquarters of NOAA's National Undersea Research Program at University of Connecticut, located at Avery Point, Connecticut.

tance to both Federal and State resource and environment management officials.

In response to these research interests, the University of Connecticut's program is planning two major undersea research events for 1984: a symposium at Avery Point in May, and a 20-day cruise in the Gulf of Maine in the summer. The topic of the May conference is: Outer Continental Shelf—Manned Undersea Research. The cruise, which will involve participation by the U.S. Corps of Engineers and the Environmental Protection Agency, will have three "legs" or phases. Each leg will focus on one of the three research priorities established by the Advisory Board: marine pollution, fisheries productivity, or disputed territory habitat definitions. A comparison of manned vs. unmanned assessment techniques for photographic documentation and sampling will also be made; during the cruise, the performance of a manned submersible will be compared to that of a remotely operated vehicle on a series of carefully defined tasks.

SECTION III

SUBMERSIBLE SUPPORT PROGRAMS

BACKGROUND

Submersible vehicles have been one of the principal undersea research tools used by NOAA's research program since 1971. The program has made use of both deep- and shallow-water submersibles that are owned and operated by private companies, institutions, and the Navy. NOAA's role is to provide peer review of proposals submitted by NOAA scientists wishing to use various submersible vehicles, and then to fund the submersible portion of any research that is performed after a proposed project has been selected.

In 1983, NOAA extended its research submersible program to colleges and universities participating in the National Sea Grant Program. In the future, scientists from Sea Grant institutions will be permitted to submit proposals for research projects that qualify for NOAA-sponsored use of shallow- or deep-water submersibles.

NOAA has found submersibles ideal for direct in-water observation of the underwater environment. Submersibles are particularly valuable in helping scientists to understand underwater phenomena that involve time-related or dynamic functions, such as sediment transport, current activity, or benthic reworking. In areas of rough bottom topography, studies of animal behavior and species distribution are nearly impossible to perform without the use of submersibles. Ocean dumping studies and many other types of undersea environmental assessments are also best performed via submersible vehicles. In addition, actual underwater photographs, core samples, and measurements often make interpretation of existing data easier, by providing important "hands-on" clues to underwater events.

DEEP-WATER SUBMERSIBLE PROGRAMS

ALVIN/LULU

The deep-water submersible ALVIN, which has a depth capability of 4,000 meters, is owned by the U.S. Navy and operated by the Woods Hole Oceanographic Institution. NOAA's Office of Undersea Research supports use of the ALVIN, with its support ship LULU, for a total of 30 days per year. NOAA, ONR, and the National Science Foundation have a tri-agency support agreement that governs use of the ALVIN/LULU system; the most recent 3-year agreement was signed in 1981. Figures III-1A, B, and C show various views of the ALVIN.

Selection of ALVIN Science Missions

Proposals submitted are initially reviewed by a peer review panel of marine scientists from several different oceanographic disciplines. Selection criteria include conformance of the proposed research with the goals of NOAA, scientific merit, and importance of a submersible to the overall design of the proposed research. Proposals selected in initial review are then passed on to the University National Oceanographic Laboratory System (UNOLS) committee, which makes the final selection and then schedules use of the ALVIN for the coming year.

NOAA-sponsored and supported deep-water submersible research projects conducted in the ALVIN since 1979 are shown in table III-1. In 1982, the

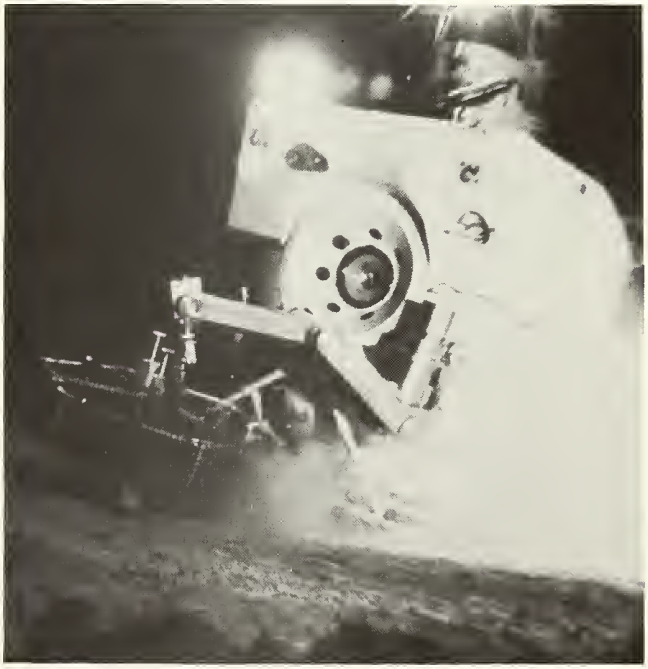


Figure III-1A.—ALVIN performing manipulative task on the seafloor

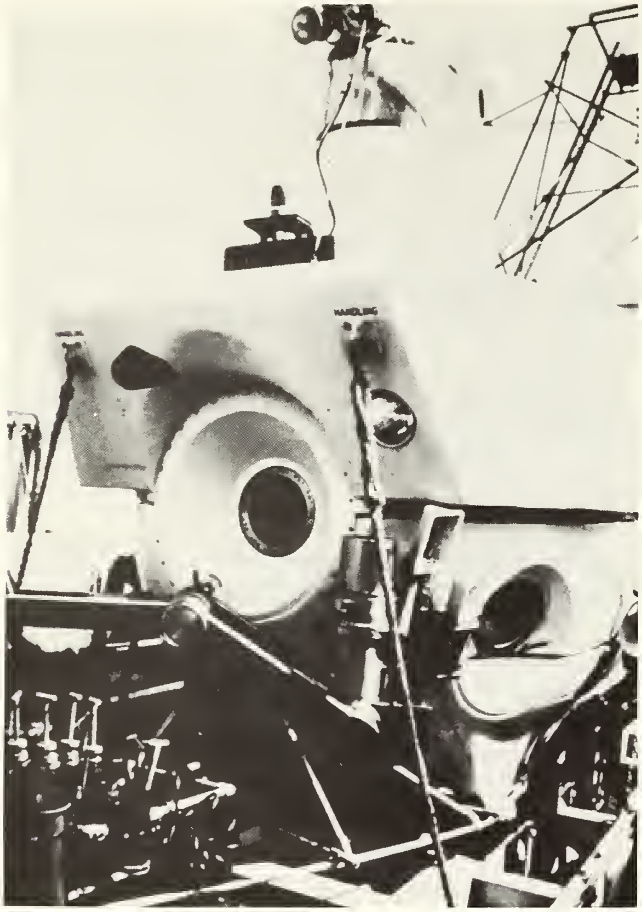


Figure III-1B.—ALVIN on deck before a mission.

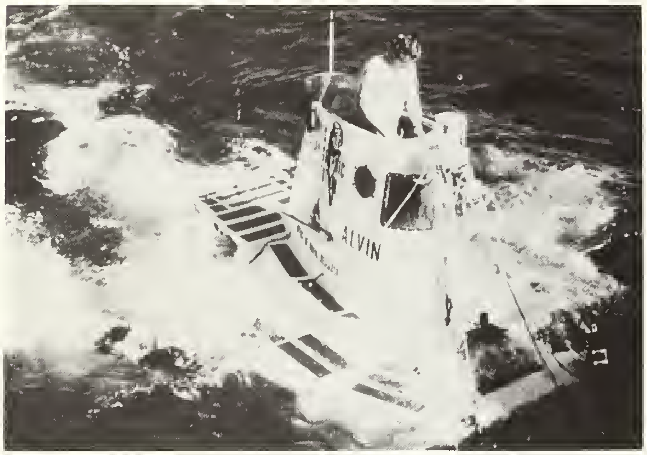


Figure III-1C.—ALVIN surfacing after mission.

ALVIN/LULU system was involved in two missions, described below. NOAA scientists from the Atlantic Oceanographic and Meteorological Laboratories and the National Marine Fisheries Service led these research projects. During 1983, no NOAA-sponsored ALVIN/LULU dives were conducted, because the ALVIN was being refurbished.

Hydrothermal Fields on the Mid-Atlantic Ridge

With the help of ALVIN, investigators from the Massachusetts Institute of Technology, the Woods Hole Oceanographic Institution, and NOAA's Atlantic Oceanographic and Meteorological Laboratory conducted an investigation of hydrothermal activity at the TAG hydrothermal field. The mission was jointly sponsored by the National Science Foundation and the Office of Undersea Research and involved geochemists, geophysicists, and geologists from the participating institutions. Figure III-2 shows a view of the TAG field from ALVIN.

Use of the ALVIN permitted scientists to make the first direct observations of an active hydrothermal field on a slow-spreading oceanic ridge, the Mid-Atlantic Ridge. The scientists took chemical and thermal measurements in the water column and samples of hydrothermal mineral deposits on the seafloor. The results of this mission were presented at several scientific meetings, and papers describing the observations and findings of these dives are presently in press.

Oceanographer Canyon Study

Continuing a series of studies initiated in 1974, the National Marine Fisheries Service performed six dives in Oceanographer Canyon in August and September 1982. The long-term objectives of this research include describing the fauna of the canyon, developing bathymetric maps of the area, and observing the surficial geology, sedimentary features, and erosional processes that characterize the canyon. The 1982 ALVIN/LULU mission contributed to these long-term goals by adding substantial information to the existing data base on canyon biota, habitats, substrates, and dynamic processes.

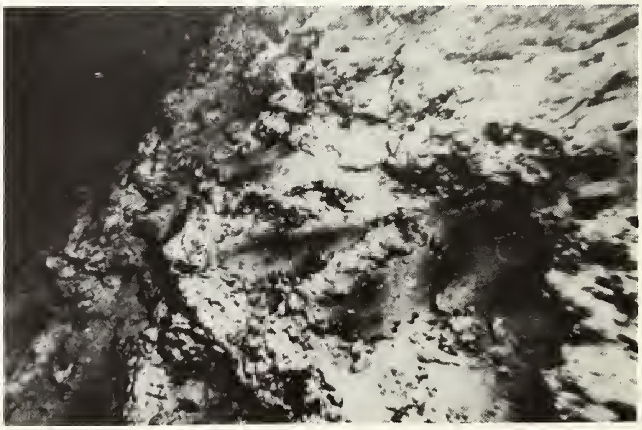


Figure III-2.—View of hydrothermal field taken from the ALVIN.

Table III-1.—NOAA-Supported Deep-Water Submersible Research Projects

Dates	Project	Location	Principal Investigator
		1979	
Aug. 21-31	Deep Ocean Mining Environmental Survey	Off California	R.E. Burns, Atlantic Oceanographic and Meteorological Laboratory
Nov. 25—Dec. 15	Galapagos Rift Thermal Vent Area Study	Galapagos	D. Cohen, National Marine Fisheries Service
		1980	
Jan. 5-21	Submarine Micromorphology of Eastern Galapagos Ridge	Panama Basin	A. Malahoff, National Ocean Survey
Aug. 15-22	Biological and Geological Studies	Oceanographer Canyon	R. Cooper, Northeast Fisheries Center
Oct. 1-13	Wilmington Geotechnical Corridor Study	Wilmington Canyon	D.N. Lambert, Marine Geology and Geophysics Laboratory
		1981	
Jan. 30—Feb. 2	Fate of Shallow-Water Sediments in a Deep Basin	Off St. Croix	Dennis Hubbard, West Indies Laboratory, Fairleigh Dickinson University
Aug. 18—Sept. 2	Ecuador Rift/Inca Transform/Galapagos Rift Study	Galapagos	A. Malahoff, National Ocean Survey
		1982	
July	Geological, Geophysical, and Geochemical Studies of Mid-Atlantic Ridge Hydrothermal Fields	TAG Hydrothermal Field	P. Rona, Atlantic Oceanographic and Meteorological Laboratory
Aug.—Sept.	Biological and Geological Studies	Oceanographer Canyon	R. Cooper, J. Uzmann, National Marine Fisheries Service

SHALLOW-WATER SUBMERSIBLE PROGRAMS

Shallow-water submersibles have played an important role in NOAA-sponsored undersea research efforts in the last decade, especially in the area of research into the natural processes and animal habitats of U.S. coastal zones. This research has been facilitated by a series of cooperative agreements between NOAA and the Harbor Branch Foundation, under which NOAA and the Foundation jointly sponsor underwater research projects of interest to both organizations. Harbor Branch submersibles and support ships have been used extensively for NOAA-sponsored research dives, and this practice continued in 1982-83. The submersible/support vessel systems in use in this period included the JOHNSON SEA-LINK/JOHNSON, NEKTON GAMMA/GOLD N CLOUD (fig. III-3), and the MERMAID/ALOHA. Shallow-water submersible research expeditions supported by NOAA's Office of Undersea Research since 1982 are shown in table III-2.

Figure III-3.—The shallow-water submersible NEKTON GAMMA on a mission.

Table III-2.—NOAA-Sponsored Shallow-Water Submersible Cruises, 1982-83

Dates	Support Ship/Submersible	Purpose/Location	Principal Investigator/Affiliation
July 1982	GOLD N CLOUD/ NEKTON GAMMA	Assess Halibut Longline Bait Loss; Compare Effectiveness of Fishing Gear; Determine Distribution of Juvenile Rockfish/Kodiak Island, Alaska	W. High, Northwest and Alaska Fisheries Center; International Pacific Halibut Commission; Alaska Department of Fish and Game
July—August 1982	R/V JOHNSON/ JOHNSON SEA-LINK	Baseline and Monitoring Studies in Oil and Gas Drilling Areas; Fisheries Research; Study of Bioluminescent Phenomena in the Ocean/U.S. East Coast	R. Cooper, J. Uzmann, National Marine Fisheries Service; R. Jones, Harbor Branch Foundation; K. Stehling, Ocean Technology and Engineering Services
July—September 1983	R/V JOHNSON/ JOHNSON SEA-LINK	Water Column Ecology; Georges Bank Fisheries Study; Lobster Ecology; Tile Fish Studies; MONITOR Sanctuary; Reef Fish Habitats and Distribution/U.S. East Coast	R. Cooper, National Marine Fisheries Service; R. Jones Harbor Branch Foundation; Gordon Watts, National Ocean Service
July—August 1983	ALOHA/MERMAID II	Assess Halibut Longline Bait Loss; Compare Effectiveness of Fishing Gear; Juvenile Rockfish Distribution; Rockfish Species Identification/Kodiak Island, Alaska	W. High, Northwest and Alaska Fisheries Center; International Pacific Halibut Commission; Alaska Department of Fish and Game

Shallow-Water Submersible Missions, 1982

Two major shallow-water submersible projects were carried out in 1982, one on the east coast and one on the west. The west coast project, named SEA SUB, involved 48 submersible dives and was conducted in July-August 1982. The east coast missions utilized the R/V JOHNSON (fig. III-4A) and the JOHNSON SEA-LINK (fig. III-4B) submersible and consisted of three different "legs" or segments, each dedicated to a specific research objective.

1982 Project SEA SUB Dives

Scientists from the Northwest and Alaska Fisheries Center of the National Marine Fisheries Service (NOAA), the Alaska Department of Fish and Game, and the International Pacific Halibut Commission participated in this expedition, which involved research dives to depths of 800 fsw. The GOLD N CLOUD (fig. III-5) served as the launch, recovery, and support ship.

Project SEA SUB had four major scientific objectives:

- Assess factors associated with halibut longline bait loss
- Study behavior of king and snow crab
- Identify areas inhabited by juvenile rockfish
- Observe behavior and distribution of shrimp species on commercial fishing grounds

Results of the project showed that halibut preferred certain types of bait, e.g., herring, and were often able to escape from the fishing gear used to hook them. Figure III-6 shows a fish hooked on longline gear. As a result of this project, fishermen have shifted to use of a circle rather than the traditional J hook; the new type of gear has increased the catch by 60 percent. King crab were observed only in a narrow zone near Chiniak Bay and at depths greater than 400 fsw, while snow crabs were more widely distributed. No juvenile rockfish were identified during any of the dives. Pink shrimp (*Pandalus* spp.) were seen in abundance in areas where the seafloor was covered with fine silt. In addition, two abandoned and damaged king crab pots were observed.

East Coast Shallow-Water Cruise, 1982

Three distinct legs were involved in the SEA LINK's 1982 summer cruise: a Georges Bank baseline and monitoring phase, a tilefish ecology study, and a continuation of OUR's earlier support of research into ocean-related bioluminescent phenomena. Each leg is described separately below.

LEG I—GEORGES BANK AREA MONITORING STUDIES—PROJECT OCEAN PULSE

Scientists from NOAA's Northeast Fisheries Center (National Marine Fisheries Service), the University of New Hampshire, and the U.S. Geological Survey carried out another in a series of dives designed to establish baseline conditions in several east coast oil and gas drilling areas on the Outer Continental Shelf. Figure III-7 shows a map of the area, including the site-specific monitoring stations established on earlier OCEAN PULSE missions.

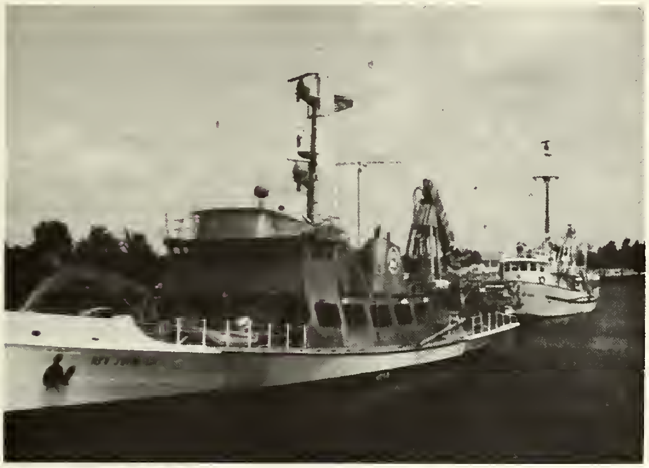


Figure III-4A.—The R/V JOHNSON, support ship for the research submersible JOHNSON SEA-LINK.

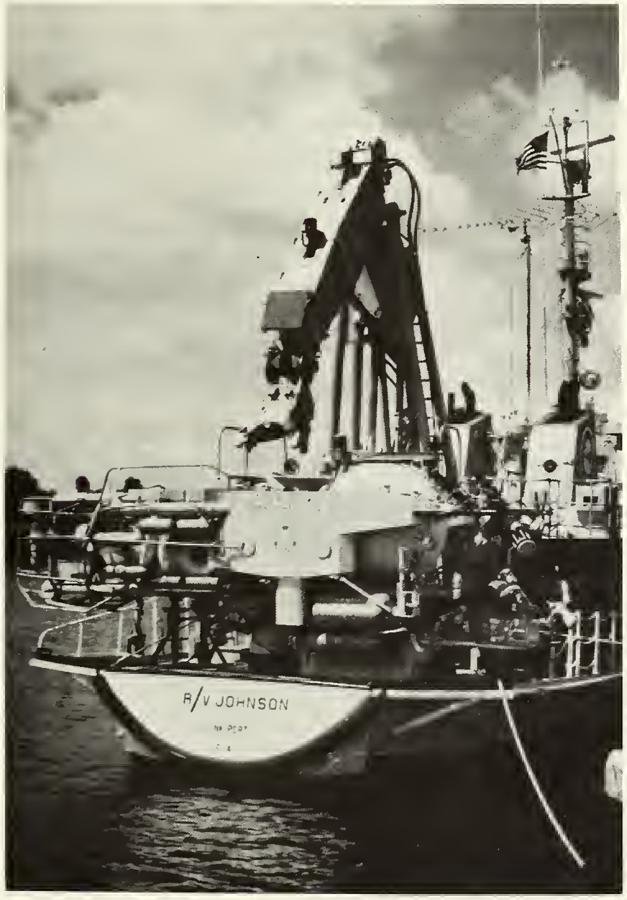


Figure III-4B.—The research submersible JOHNSON SEA-LINK on a NOAA cruise.

The principal goals of the OCEAN PULSE project are:

- Establish pre-drilling baselines for faunal abundance, species diversity and distribution
- Determine tissue- and substrate-bound levels of contaminants (hydrocarbons, PCB's, and trace metals)
- Compare biotic and abiotic features of the ocean floor
- Document via photographs environmental and other features of the submarine canyons

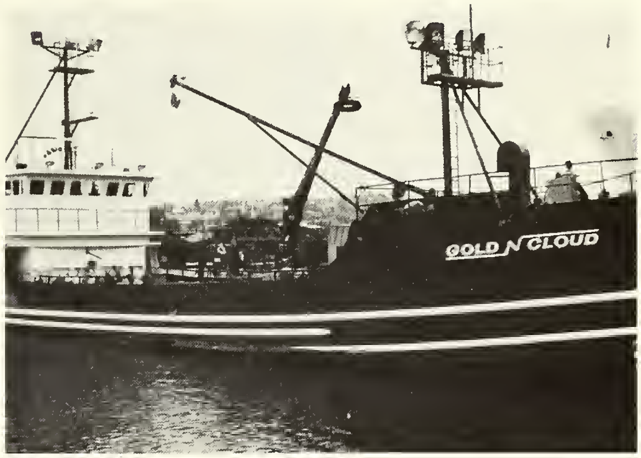


Figure III-5.—The support vessel GOLD N CLOUD off the coast of Alaska.

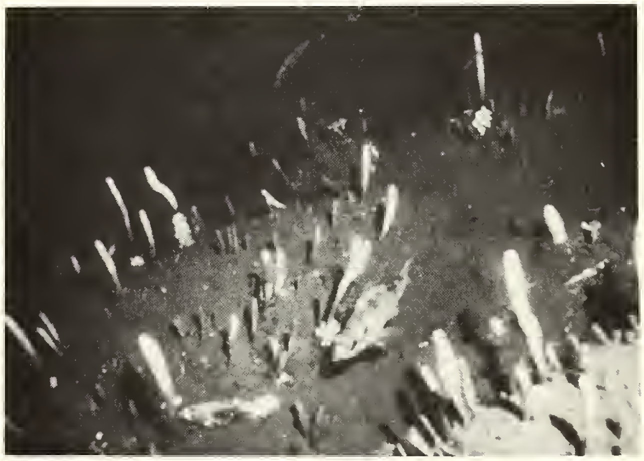


Figure III-6.—Fish caught on longline gear during Alaskan submersible cruise.

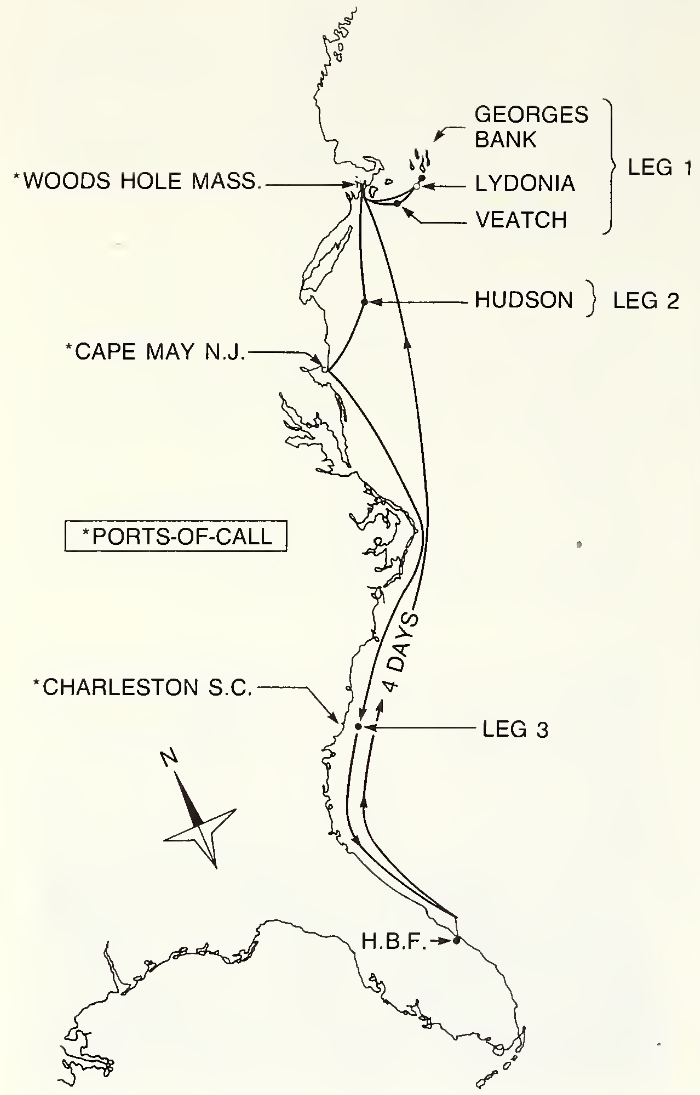


Figure III-7.—Route of 1982 shallow-water submersible cruise.

The 1982 OCEAN PULSE project involved 19 dives to existing monitoring stations and the establishment of a new station in Veatch Canyon. In addition, the surficial geology of the upper area of Oceanographer Canyon was described and documented, and specimens of several of the key indicator species used to monitor contaminant levels were captured for later analysis. More than 22,000 photographs were taken during this mission. To improve NOAA's ability to monitor PCB concentrations accurately, the OCEAN PULSE program will be expanded in the future by the addition of several monitoring stations.

LEG II—FISHERY RESEARCH DATA CRUISE

During the second phase of SEA-LINK's 1982 cruise, Harbor Branch Foundation personnel and scientists from Rutgers University and the U.S. Geological Survey continued studies on the commercially important Atlantic Golden Tilefish. Tilefish and their burrows were mapped at three locations adjacent to Hudson Canyon, and photographs were taken of tilefish in their burrows. Results of this project show that heavy commercial fishing in this area of the coastal zone has had a serious impact on the number of adult and juvenile tilefish resident in this region. A tilefish entering its burrow is shown in figure III-8.

LEG III—BIOLUMINESCENCE PROFILING STUDY

Scientists from Harbor Branch, the Naval Ocean Systems Center, the Naval Oceanographic Office, the Naval Research Laboratory, and NOAA participated in two dives in 1982 that were part of a cooperative NOAA-Navy project to study bioluminescent ocean phenomena. Bioluminescence and temperature changes were profiled during descent and ascent; the dives utilized the submersible SEA-LINK and involved depths as great as 600 meters.

Use of a manned submersible has proved particularly valuable in bioluminescence research, because scientists have been able to correlate individual bioluminescent flashes with the organisms generating them and to relate bioluminescence and organism counts to water temperature. In addition, submersibles permit researchers to understand the role of bioluminescence by observing its biological functions in the natural environment.

Shallow-Water Submersible Cruises, 1983

The Office of Undersea Research sponsored two major shallow-water cruises in 1983: one on the east coast Atlantic Continental Shelf and a second in the Pacific in an area 20 miles offshore from Sitka, Alaska. The eastern cruise consisted of six phases or "legs" and lasted for more than 2 months. The Alaskan mission, which was the second annual SEA SUB expedition, was of shorter duration and had narrower objectives.

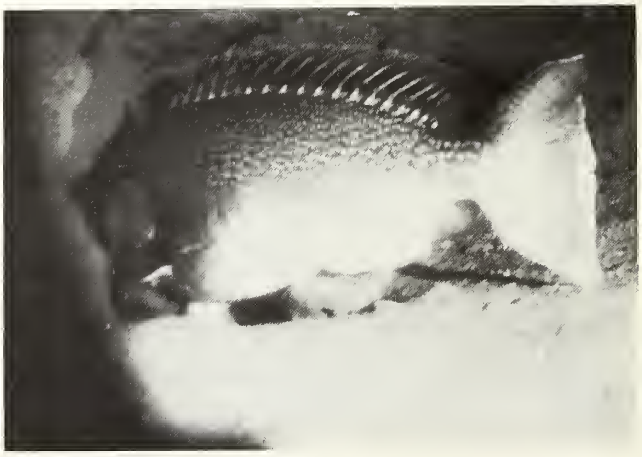


Figure III-8.—A tilefish entering its burrow on the seafloor.

1983 Project SEA SUB Dives

The four institutions that participated in the 1982 SEA SUB expedition off the coast of Sitka, Alaska, joined together to sponsor the 1983 follow-on studies. The mission's objectives included a comparative evaluation of the effectiveness of various baits (herring, salmon, octopus) for halibut fishing, as well as the relative efficacy of different types of longline gear. Results again showed that herring was the preferred bait and that circle hooks were more successful in catching both rockfish and halibut. A total of 52 submersible dives were made in 1983 in connection with this research project.

1983 East Coast Cruise

Each of the six legs of the 1983 East Coast submersible cruise had a distinct scientific objective and a group of scientific personnel dedicated to the mission associated with that leg. Figure III-9 shows the cruise route followed by the R/V JOHNSON and the JOHNSON SEA-LINK over the 10-week period of the cruise.

LEG I—GULF OF MAINE AND GEORGES BANK

The cruise's first phase was devoted to a study of the distribution of bioluminescence at various depths. Specifically, scientists studied the bioluminescent pulse repetition rate, wavelength, or wavelength distribution of individual or collective pulses; the relationship between particular organisms, especially gelatinous ones, and specific bioluminescent events; and the composition of marine "snow." Submersible dives were made both during daylight and at night for this leg of the cruise.

LEG II—GEORGES BANK AND SUBMARINE CANYON

Dives conducted during this phase of the cruise continued the OCEAN PULSE series of research projects; for several years, the program has monitored contamination levels in several indicator species and ecosystem response in general in the area of these marine canyons.

LEG IIIA—TRUXTON SWELL REGION, GULF OF MAINE

The third phase of the cruise was divided into two phases, A and B. The Truxton Swell portion was devoted to a determination of the abundance and distribution of lobsters, scallops, shrimp, crabs, and groundfish and the mating relationship between inshore and offshore lobsters in this region.

LEG IIIB—MID-ATLANTIC BIGHT, OUTER CONTINENTAL SHELF

The dives conducted during this phase of the third segment of the cruise continued the assessment of the distribution, abundance, habitat, community structure, and behavior of the commercially important tilefish. Side scan and echo sounding techniques were used to study the relationship between tilefish behavior and topographical features.

LEG IV—MONITOR MARINE SANCTUARY

This leg of the 1983 cruise involved marine archeological explorations and surveillance of the marine sanctuary where the shipwrecked USS MONITOR lies. The MONITOR (fig. III-10) acts as an artificial reef for several species of marine fish, and scientists are also interested in documenting the status of the sunken wreck on video tape.

LEG V—ONSLOW BAY

Ten monitoring sites were visited during this leg of the cruise to determine the biomass of fish populations in the Onslow Bay area. In addition, scientists established transects to aid in counting specimens of different fish species.

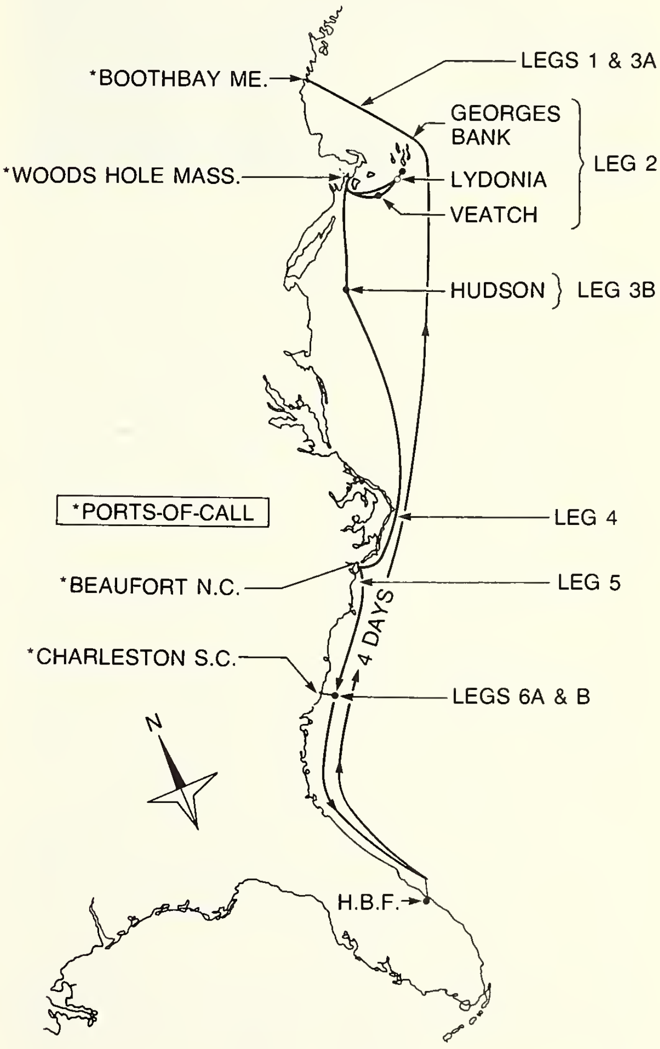


Figure III-9.—Cruise route of the R/V JOHNSON and SEA-LINK, 1983.

Figure III-10.—Civil War battleship MONITOR, shown above in artist's drawing, now provides shelter for fish in the Monitor Marine Sanctuary.

LEG VI—CHARLESTON LUMPS AREA

The principal objectives of the final leg of the 1983 cruise included the determination of species and size selectivities of various kinds of passive longline fishing gear and an assessment of the physical and biological factors influencing the effectiveness of passive fishing gear of various types. Scientists also investigated the extent to which replenishment of commercially valuable deep-reef fishes has occurred.

REMOTELY OPERATED VEHICLES

EPAULARD Cruise

In May 1983, NOAA chartered the R/V ALOHA and the remotely operated deep sea search and recovery vehicle EPAULARD from International Underwater Contractors, Inc. The objectives were to perform a field test and evaluation of the EPAULARD system and to explore the seafloor topography and bottom fauna of Gorda Ridge off the coast of Oregon and map areas of polymetallic sulfide deposits discovered on earlier submersible missions. This system accomplished these objectives in a series of five dives off Newport, Oregon.

Scientist/observers on board the ALOHA were from NOAA's Northeast Fisheries Center. The EPAULARD has a depth capability of 6,000 meters and operates without a tether or umbilical; it is launched from the support ship and is acoustically controlled. In the absence of periodic commands, the ROV automatically releases its ascent weight and surfaces. The EPAULARD can be programmed to run a predetermined course, and this course can be changed if the acoustic commands emanating from the support ship are changed. The system has on-board processing capabilities for both color and black-and-white film.

The EPAULARD system performed well, and NOAA scientists believe it has the capability to perform deep submergence studies at great depths, in cold waters, and at moderate cost. Figures III-11A, B, and C show the EPAULARD system on board the R/V ALOHA.

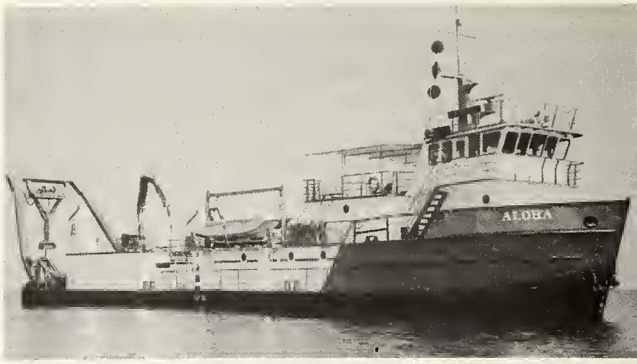


Figure III-11A.—EPAULARD's support ship ALOHA.

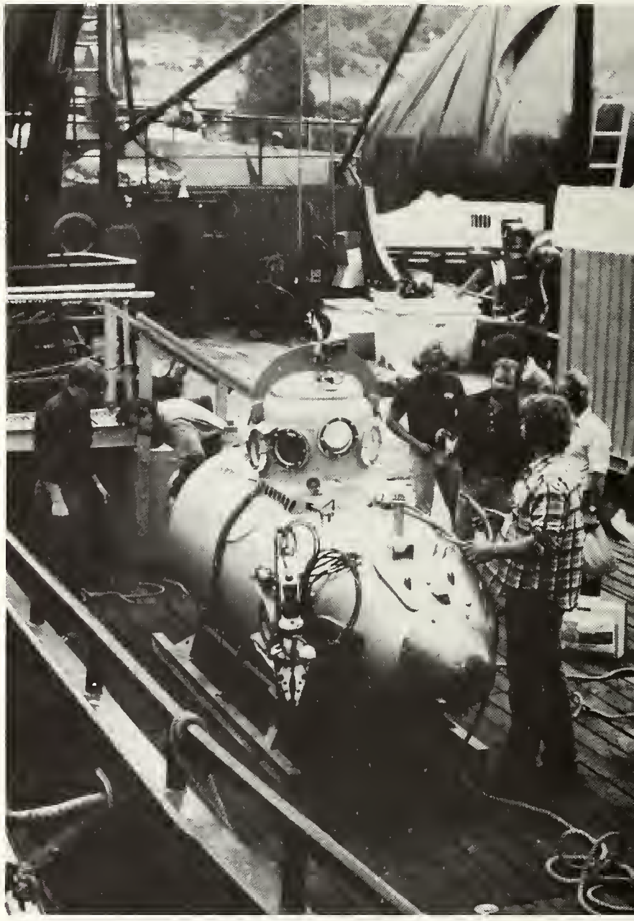


Figure III-11B.—EPAULARD on deck before deployment.

ROV-Submersible Comparison Cruise

In September 1982, a HBF/OUR mission was conducted comparing the functional undersea research capabilities of a manned submersible and a remotely operated vehicle (ROV). A senior Japanese engineer from the Deep Sea Research and Submersible Operations Department of the Japan Marine Science and Technology Center (JAMSTEC) participated in the cruise as an observer.

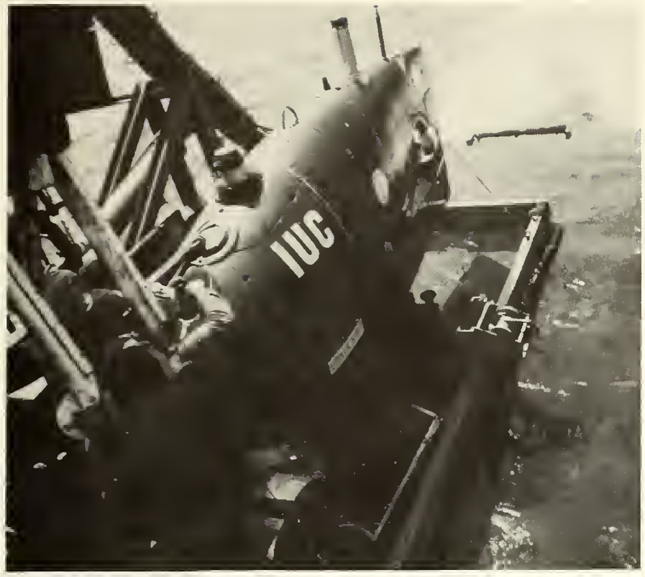


Figure III-11C.—EPAULARD ready for launch.

The vehicles used for the comparison cruise were the R/V JOHNSON and the manned submersible JOHNSON SEA-LINK, and the R/V SEA DIVER and ROV CORD (fig. III-12). Plans called for divers to run a transect across the seafloor while the ROV took pictures and samples, and then to use the submersible to follow the same transect lines and to make video observations, which would later be compared to ones taken with the ROV. Bad weather severely limited the amount of data that could be collected, and the project has been rescheduled for 1984.

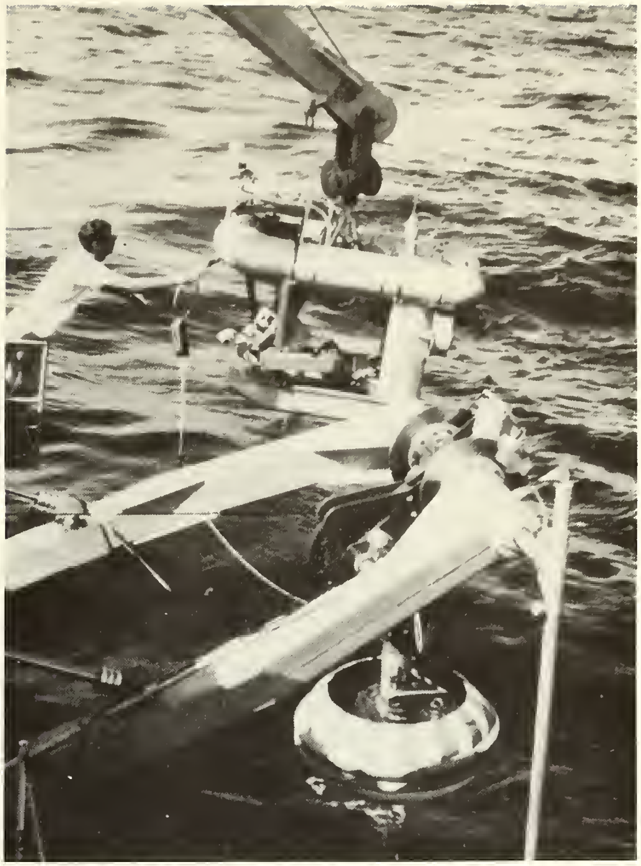


Figure III-12.—Remotely operated vehicle CORD.

SECTION IV

INTERNATIONAL AND INTERAGENCY PROGRAMS, AND INFORMATION TRANSFER ACTIVITIES

BACKGROUND

Since its founding in 1971, NOAA's undersea research program has actively participated in joint efforts with other countries to further the goals of marine science. To date, the Office of Undersea Research and its predecessor have joined with marine scientists from universities, research institutions, and government agencies in Japan, France, the United Kingdom, Canada, Poland, the German Democratic Republic, the Federal Republic of Germany, Belgium, the USSR, Kuwait, Turkey, and Norway to conduct international programs in the area of underwater research.

INTERNATIONAL ACTIVITIES

Japan

In 1964, the United States-Japan Cooperative Program in Natural Resources (UJNR) was established as a result of a decision by the Cabinet-level U.S.-Japan Committee on Trade and Economic Affairs that exchanges of information, scientific personnel, technical data, and research equipment related to natural resources would be beneficial to both countries. The UJNR Program's objectives are to increase the efficiency of natural resource development and planning by reducing duplication and encouraging international cooperation.

Seven of UJNR's panels deal with marine science:

- Aquaculture Panel
- Diving Physiology and Technology Panel
- Marine Electronics and Communications Panel
- Marine Facilities Panel
- Marine Geology Panel
- Marine Mining Panel
- Seabottom Surveys Panel

The UJNR sponsors a conference every 2 years that meets alternately in Japan and the United States.

Personnel from the Office of Undersea Research headed the U.S. delegation to the Diving Physiology and Technology Panel, which met in Japan in 1983 in connection with the Eleventh Biennial Meeting of the UJNR. In 1982, under the auspices of the UJNR panel, a senior engineer from JAMSTEC participated as an observer in the ROV-Submersible Comparison Cruise described in section III. NOAA and JAMSTEC expect to conduct an increasing number of joint missions in the future.

France

Several U.S. agencies, including NOAA, participate in the U.S.-France Cooperation in Oceanography program. OUR has contributed to this group's work in several subject areas, including diving medicine, hyperbaric research, and man-in-the-sea research. In 1982 and 1983, OUR personnel attended meetings in France and the United States, and at one session an OUR paper describing NOAA's manned undersea research efforts was presented.

In 1982, NOAA's undersea research program was described to attendees at a meeting of the International Conference on Underwater Operations and Techniques in Paris. The paper, entitled "Marine Science Laboratories Move Into the Sea," was designed to acquaint marine scientists and researchers from around the world with NOAA's unique national undersea research program and facilities.

OUR also sponsored a joint U.S.-French research expedition utilizing the Caribbean-based habitat HYDROLAB. Two European scientists, Dr. Bay of the University of Liege (Belgium) and Dr. Falconetti of the University of Nice (France), conducted two saturation missions at NOAA's National Undersea Research Program at Fairleigh Dickinson University at St. Croix to study the development and growth of algae of the *Caulerpa* species. Two articles describing this mission appeared in the French magazines *Science et Vie* and *Oceans.*

U.S.-Kuwait Undersea Research Projects

Marine scientists from the Mariculture and Fisheries Department of the Kuwait Institute for Scientific Research in Salmiya, Kuwait, headed a team of U.S.-Kuwait aquanauts investigating the use of artificial reefs by three species of fish: groupers, coneys, and red hinds. The team used the habitat HYDROLAB and the other facilities of NOAA's National Undersea Research Program at Fairleigh Dickinson University

(St. Croix) as the "base camp" for the missions, which were conducted in 1982 and 1983.

Building on scientific information gathered by other scientists during earlier HYDROLAB missions, the Kuwaiti scientists investigated the size of the grouper, coney, and red hind populations that were using the artificial reefs established by NOAA scientists in the Salt River submarine canyon. These missions were designed to determine whether artificial reefs play a static or dynamic role in increasing the size of local fish populations, a finding of particular relevance to fisheries productivity.

INTERAGENCY PROGRAMS

U.S. Underwater Diving Fatality Statistics

For more than a decade, NOAA and the U.S. Coast Guard have supported the National Underwater Accident Data Center, a project headquartered at the University of Rhode Island. The program collects and analyzes all available information on underwater diving fatalities occurring in the United States. The information developed by the Center is widely disseminated to sport diving training institutions, diving equipment manufacturers, commercial diving companies, trade associations, unions, recreational divers, and the general public, and serves to alert people to the types, causes, and prevention of diving accidents.

Accident information is obtained from media clipping services, autopsy reports, the Diving Accident Network, Federal and state government agencies, diver training organizations, police departments, and other sources. The information received is analyzed as to cause, mode of diving, characteristics of the victim, environmental conditions, and equipment in use, and significant findings are published as aids to diving accident prevention. An update of the Center's *U.S. Underwater Diving Fatality Statistics* will be published in 1984.

Institute for Environmental Medicine, Diving Data System

Since 1982, OUR has supported the Diving Research Data System (DRDS) developed and maintained by the Institute for Environmental Medicine of the University of Pennsylvania. The DRDS is also supported by the Navy. The data system provides NOAA with access to the research findings of national and international scientists in the areas of diving decompression, breathing gases, respiration, human responses to unusual environmental effects, oxygen toxicity, pressure-related diseases and conditions, and hyperbaric therapy.

The Diving Research Data System has four main objectives:

- To make available to civilian Federal agencies such as NOAA a reliable data base of validated diving accident therapy information
- To systematize methods of observing and recording diving-related data
- To provide a system capable of storing records, analyzing models, and generating diving decompression and treatment schedules
- To prevent the loss of significant technical information in the fields of diving physiology and safety

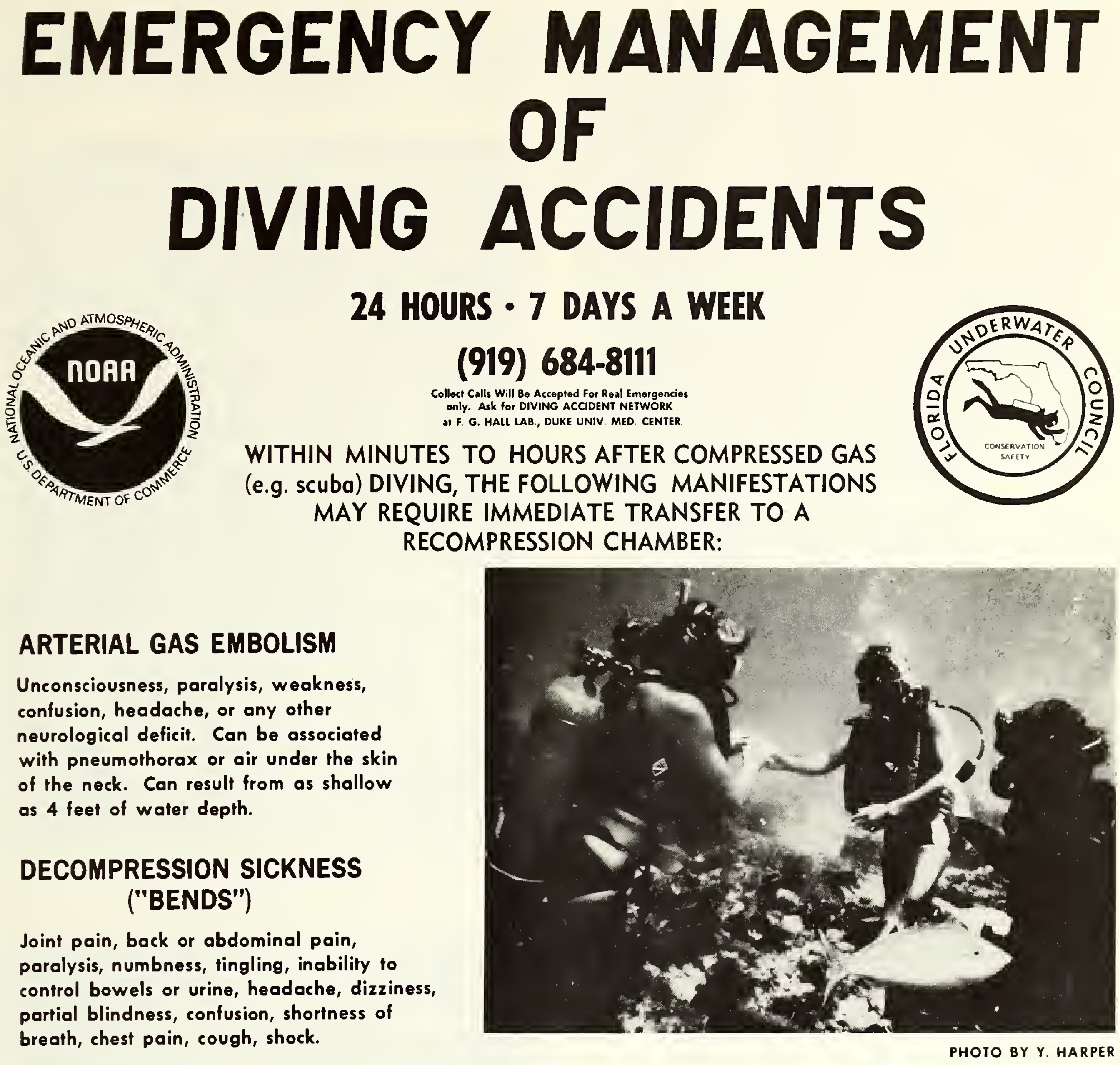
To date, the system has been widely used by military and civilian facilities in the United States and by research institutions in several foreign countries. OUR has found the system particularly useful in improving the safety and effectiveness of shallow saturation diving projects conducted in support of NOAA's responsibilities under the Outer Continental Shelf Act.

National Diving Accident Network

The large increase in the number of sport divers in the United States and the acute shortage of physicians trained to treat diving accidents led the Office of Undersea Research in 1981 to join with the Department of Energy and the National Institute for Occupational Safety and Health to support the establishment of the Diving Accident Network (DAN). DAN maintains headquarters at Duke University, and the Undersea Medical Society provides administrative support for the Network.

The Network provides 24-hour medical consultation on the recognition, immediate care, transportation, and recompression chamber treatment of diving accident victims anywhere in the United States. Around-the-clock telephone service [phone number: (919) 684-8111] is in place for emergencies, and a physician trained and experienced in hyperbaric medicine is continuously on call. Posters calling attention to DAN's program have been widely distributed in dive shops, hospital emergency rooms, doctors' offices, and other appropriate places (fig. IV-1). The national Network is administratively divided into seven geographical areas, each with a trained medical director. The regions are: Southwest, Northeast, Midwest, Gulf, Northwest, Southeast, and Pacific.

The Network also maintains a complete list of all U.S. recompression chambers and their current status. Information on the availability of air ambulance services to transport injured divers to appropriately equipped medical care facilities is available by calling the Network.



EMERGENCY MANAGEMENT OF DIVING ACCIDENTS

24 HOURS • 7 DAYS A WEEK

(919) 684-8111

Collect Calls Will Be Accepted For Real Emergencies only. Ask for DIVING ACCIDENT NETWORK at F. G. HALL LAB., DUKE UNIV. MED. CENTER.

WITHIN MINUTES TO HOURS AFTER COMPRESSED GAS (e.g. scuba) DIVING, THE FOLLOWING MANIFESTATIONS MAY REQUIRE IMMEDIATE TRANSFER TO A RECOMPRESSION CHAMBER:

ARTERIAL GAS EMBOLISM

Unconsciousness, paralysis, weakness, confusion, headache, or any other neurological deficit. Can be associated with pneumothorax or air under the skin of the neck. Can result from as shallow as 4 feet of water depth.

DECOMPRESSION SICKNESS ("BENDS")

Joint pain, back or abdominal pain, paralysis, numbness, tingling, inability to control bowels or urine, headache, dizziness, partial blindness, confusion, shortness of breath, chest pain, cough, shock.

PHOTO BY Y. HARPER

Figure IV-1.—DAN poster, widely distributed throughout United States in dive shops, diving schools, and emergency rooms

INFORMATION TRANSFER

Symposium Series for Undersea Research

As the responsibilities, size, and importance of NOAA's undersea research program grew, it became increasingly clear that the scientists who participated in OUR-sponsored projects needed a national forum for the exchange of ideas and presentation of papers related to their research. In response to this need, OUR has undertaken the sponsorship of an annual symposium that will be centered on a particular scientific topic.

The first of these symposia was held in conjunction with the annual meeting of the American Society of Zoologists (ASZ) in December 1983. The scientific theme of the meeting was the ecology of the coral reef, and the workshop was sponsored by NOAA and the Division of Ecology of the ASZ. Professor Marjorie Reaka of the University of Maryland was chairperson of the workshop and editor of the *Proceedings*, which were published under the title, *The Ecology of Deep and Shallow Coral Reefs* (fig. IV-2).

Nineteen papers were presented at the meeting, and workshop sessions were devoted to the following subjects: Growth and Life History Patterns of Coral Reef Organisms; Dynamics of Recruitment in Coral Reef Organisms; Organization of Coral Reef Communities; and Organization of Coral Reef Ecosystems. The success of the first annual symposium has led OUR to plan a second, to be held in May 1984, at the University of Connecticut. The theme of the workshop will be "Manned Undersea Research on the Mid and Outer Continental Shelf and Slope of New England and the Mid-Atlantic Bight."

Hazards of Diving in Polluted Waters

For several years, OUR supported a research project on the chemical and microbial hazards confronting divers who must work in polluted waters. The scientists responsible for the direction of the project have been Dr. Rita Colwell of the University of Maryland and Dr. James Coolbaugh of the Naval Medical Research Institute; these scientists have presented numerous papers at scientific meetings and have published their findings in several scientific journals.

In 1982, Dr. Colwell presented a paper, "Microbial/Chemical Hazards to Divers in Polluted Waters," at a workshop on the protection of divers occupationally exposed to chemical, pathogenic, or radioactive hazards. The paper stressed the "double" hazard to which divers are exposed who work in waters contaminated by both domestic sewage and toxic chemicals, such as the Potomac River, the Chesapeake Bay, and the Puerto Rico Trench of the Atlantic Ocean. The study recommended that research be undertaken to assess the risk to which such divers are exposed and to develop cost-effective methods of protecting these divers.

Undersea Medical Society Activities

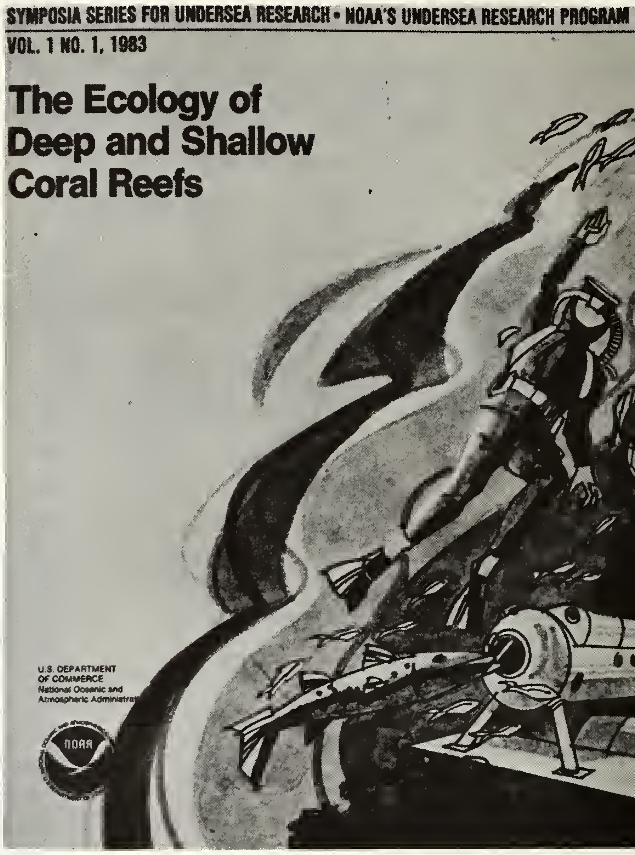
In the 1982-83 period, OUR continued its support of several important information transfer programs performed for NOAA by the Undersea Medical Society (UMS) under a contract with the Office of Undersea Research. Figure IV-3 shows the logo of the UMS. This program is broad in scope and is designed to provide NOAA with current information on recent developments in the fields of diver training, medicine, treatment procedures, research, and technology.

The UMS is uniquely qualified to provide this type of technical support because the society's membership is comprised of 2,000 diving physicians, physiologists, and other professionals. In addition, the UMS publishes the principal journal in the underwater biomedical field, *Undersea Biomedical Research*, and a monthly newsletter, *Pressure*.

A contract with the UMS is used to support activities related to diver safety that range from lectures to workshops to hard-cover publications. In 1982-83, OUR sponsored three UMS workshops, which are described below.

Workshop on "Safe Diving Procedures for Excursions from Saturation Diving"

Members of the international diving and hyperbaric medicine community participated in a UMS Workshop on Excursions from Saturation: Procedures fo Safe Diving. The meeting was designed to serve as a forum for the exchange of practical information o procedures for dealing with problems such as acute


SYMPOSIA SERIES FOR UNDERSEA RESEARCH • NOAA'S UNDERSEA RESEARCH PROGRAM
VOL. 1 NO. 1, 1983

The Ecology of
Deep and Shallow
Coral Reefs

U.S. DEPARTMENT
OF COMMERCE
National Oceanic and
Atmospheric Administrat

Figure IV-2.—Cover of *Proceedings* of OUR's first annual symposium

UNDERSEA MEDICAL SOCIETY, INC.

Figure IV-3.—Logo of the Undersea Medical Society.

and chronic oxygen toxicity and changes such as adaptation to nitrogen narcosis, both of which may be associated with NITROX excursions from saturation storage depths.

Workshop on "Medical Aspects of Atmospheric Diving System Operations"

The trend toward the increased use of Atmospheric Diving Systems (ADS) in offshore drilling activities can be expected to continue in the next decade. At present, there are more than 45 ADS's of various types in worldwide use, and by the end of 1984, 75 units are projected to be on line. Figures IV-4A and B show the JIM and WASP atmospheric diving systems. Although no fatalities have occurred when these suits have been in use, several minor accidents have taken place. The UMS workshop focused on strategies for rescuing a stranded ADS-using diver-operator. Participants pointed out that hypothermia might compromise the ability of a stranded operator to assist in his own rescue, and that the operator's psychological reactions to his dark, cold, and isolated surroundings might further complicate the situation.

Workshop on "Oxygen: An In-Depth Study of Its Pathophysiology"

In conjunction with the Oak Ridge Associated Universities, OUR sponsored a UMS workshop on the pathophysiology of oxygen. Twenty-two papers were presented at the meeting, and topics ranged from the evolution and history of oxygen to the cellular mechanisms of oxygen toxicity and the natural defense mechanisms against the effects of oxygen and its derivatives. The *Proceedings* of the workshop will be published by the UMS in 1984.

Undersea Medical Society Publications

The Office of Undersea Research has sponsored several major publication projects undertaken by the Undersea Medical Society. In the 1982-83 period, work continued on several different books in the subject areas of undersea technology, diving medicine, and diver safety.

In conjunction with its support for training courses in diving medicine for physicians, NOAA is funding the publication of *Case Histories of Diving and Hyperbaric Accidents.* Each case featured in the book will include a complete history of the patient and details of the accident, diagnosis, details of treatment, follow-up recommendations, dive profile used, and factors contributing to the accident. The accident categories covered in the book include: Type I and Type II decompression sickness, cerebral arterial gas embolism, precipitous decompression (blowup), dysbaric osteonecrosis, near-drowning, hypoxia, inert gas effects at pressure, carbon dioxide poisoning, carbon monoxide poisoning, extra-alveolar air syndromes, oxygen poisoning, barotrauma, and hypothermia. Final publication is scheduled for 1984.

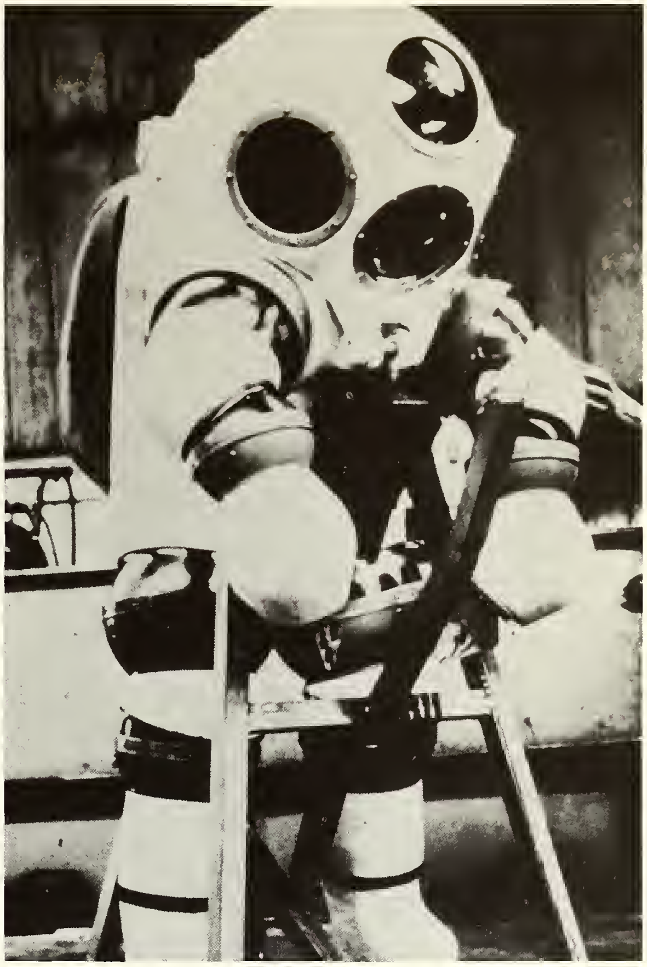


Figure IV-4A.—The atmospheric diving suit JIM, an early model of an atmospheric diving suit.

UMS is also developing a *Pictorial History of Diving Equipment and Technology,* which will document photographically the advances made in this field. As planned, the book will contain more than 1,000 photographs of personal diving equipment, SCUBA gear, breathing gas delivery equipment, lockout submersibles, diver propulsion devices, diver lockout systems, one-atmosphere diving suits, habitats, and remotely operated vehicles. Publication is planned for 1984.

Abstract Alerting Services

In its role as the U.S. clearinghouse for information on diving medicine, equipment, and technology, the UMS maintains two abstract alerting services: *Underwater Physiology Abstracts* and *Underwater Equipment & Technology Alerting Service.* The physiology abstracts summarize biomedical information from scientific and medical journals, books, symposium proceedings, workshop reports, government publications, and industry newsletters. The equipment and technology service

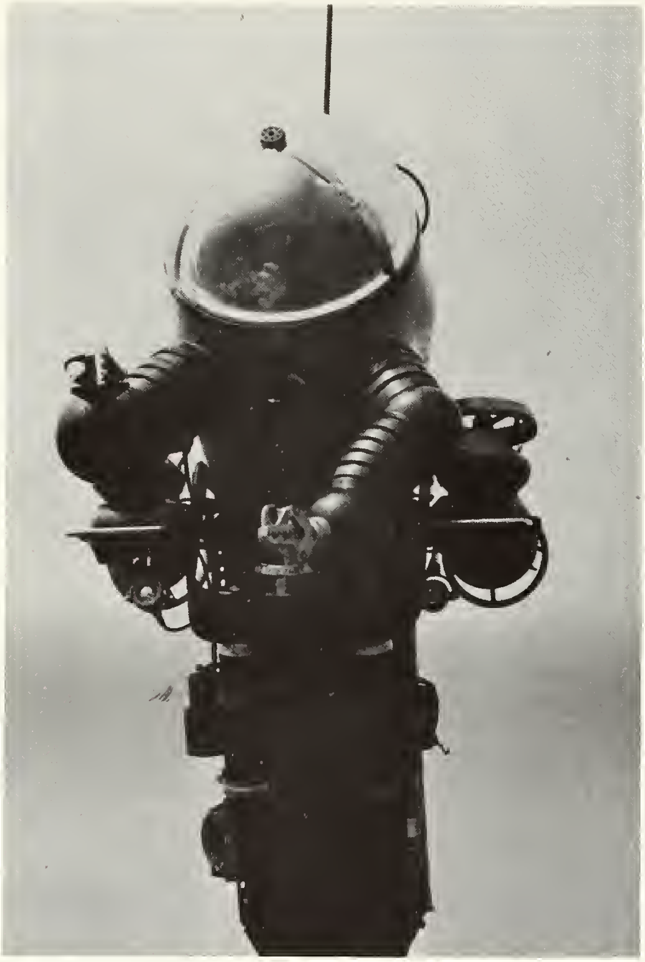


Figure IV-4B.—The atmospheric diving suit WASP.

provides abstracts of articles on diving equipment and relevant aspects of undersea engineering and includes information on meetings, publications, and news briefs of interest to readers.

For a small fee, users may request the UMS to perform literature searches on biomedical or equipment-related topics. Copies of the original articles from which the abstracts were taken are also available through the society.

Submersible Science Study

In 1979, under the aegis of the University National Oceanographic Laboratory System (UNOLS), the Lamont-Doherty Geological Observatory was awarded a grant to coordinate a study on the nation's need for submersible support in the conduct of undersea research projects. The study was supported by OUR, NSF, and ONR and was directed by the Alvin Review Committee.

The study's objective was to review past and present technical requirements of manned and unmanned underwater research facilities and to predict future demand for and technical requirements of such vehicles. A science panel composed of research scientists from several disciplines and a task force of engineers and designers of submersibles provided the technical expertise for the study. The study group published its final report, *Submersible Science Study,* in 1982. The report stressed the contribution of submersibles to our understanding of ocean floor processes and the interaction between the earth's hydrosphere and the atmosphere.

Short-Term Recommendations

The group recommended strongly that the deep-water submersible ALVIN's support ship, the R/V LULU, be replaced by a vehicle having a range of 8,000 nautical miles, a cruising speed of 10 knots, the endurance capability to remain independent of an escort vessel for 30 days, low speed maneuverability, space to support a working party of 10 aquanauts, and 1,750 square feet of laboratory area.

The study also recommended that the ALVIN be:

- Modified to a single point lift
- Improved to include scanning sonars, additional video cameras, better tools and navigation, telemetric communication to the support ship, and other electronic instrumentation

The study also identified a short-term need for the following:

- Shallow-water manned submersibles for mid-water and under-ice missions
- Robotic vehicles
- Submersible subsystems

Long-Term Recommendations

The submersible study group also made several long-term recommendations related to the science community's future needs for submersibles. These included:

- Need for a manned submersible with a 6000-meter depth capability
- Continued development of technological advances such as fuel cells, artificial intelligence devices, and fiber composite materials
- Continued funding for projects directed toward the design and building of deep-ocean submersible vehicles

Scientific topics particularly suited to future submersible research identified by the publication are: ocean crustal studies, continental margin erosion research, abyssal sedimentation projects, and mid-water and under-ice missions.

OTHER OUR ACTIVITIES

Donation of Dive System for Prisoner Rehabilitation

In 1979, NOAA acquired title to a dive system, the SDS-450, from the U.S. Navy. The system was not in operating condition, and estimates of the costs to refurbish and classify the system were as high as $100,000. Since NOAA could not use the dive system at that time, the system was donated to the California Institution for Men (CIM) in Chino, California.

The system will be used in CIM's rehabilitation program, which trains incarcerated men to become deep-sea divers. This unique vocational program, which has in the past also enjoyed the support of the U.S. Navy and the Manpower Development Training Agency, will use the SDS-450 to train enrollees in the program to refurbish, use, and maintain deep diving systems.

SECTION V

FUTURE PLANS

BACKGROUND

The Office of Undersea Research plans to continue to support many of the research programs and projects described in this and earlier annual reports. In particular, OUR intends to continue development of the network of cooperative undersea research programs established under the UNOLS initiative (see section I of this report). In the 6 years since its inception, the national program has grown from a single Caribbean facility to include five active programs located in diverse geographic regions: the Caribbean, North Carolina, Hawaii, California, and Connecticut. Plans call for continued expansion of the program to take maximum advantage of U.S. personnel and environmental marine resources.

United States-Japan Cooperative Research in Saturation Diving

NOAA has continued to participate in joint U.S.-Japan diving research and development programs, including the UJNR program described in section IV of this report. OUR is working closely with the Japan Marine Science and Technology Center (JAMSTEC), which provides a forum for marine scientists and professionals from Japanese government, academic circles, and private industry.

The Office of Undersea Research will join JAMSTEC in sponsoring a joint deep saturation dive in 1984. The dive, dubbed SEADRAGON VI, will last for 30 days and is designed to assess human renal, cardiac, and other physiological performance at a depth of 1,000 fsw. OUR personnel have the lead role in the planning of the 12th Biennial Meeting of the UJNR in 1984. The UJNR panel is planning an exchange of marine scientists and engineers between the two countries and a sharing of the two available deep-water research submersibles ALVIN (U.S.) and SHINKAI (Japan) (fig. V-1). NOAA will submit proposals to the Japanese for joint NOAA-JAMSTEC SHINKAI missions, and the Japanese will make similar suggestions for appropriate joint missions using the ALVIN.

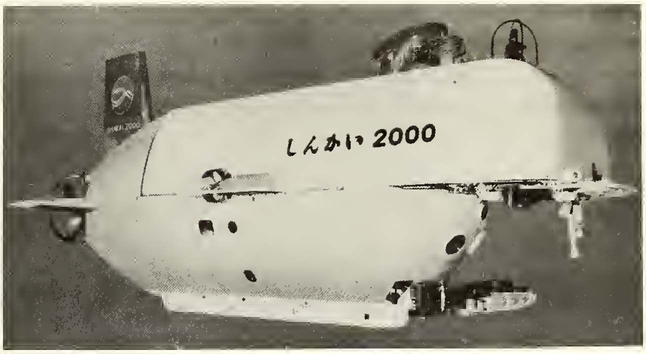


Figure V-1.—The Japanese deep-water submersible SHINKAI, to be used for joint U.S.-Japanese science missions.

Diving Medicine and Physiology Workshops

OUR will continue to support a series of workshops on timely topics of scientific interest to members of the diving medicine and research community. These workshops are arranged by the Undersea Medical Society (UMS) under a NOAA-OUR grant and are attended by experts from military, other Federal, academic, industry, and private sector circles. In 1984, OUR will sponsor four UMS workshops on the following topics: use of hydrogen as a diving gas, advances in decompression procedures after saturation, findings of recent man-in-the-cold studies, and post-accident treatment of divers.

Diving Accident Network

The success of the national Diving Accident Network (DAN), established in 1981 under the sponsorship of NOAA, the National Institute for Occupational Safety and Health, and the Department of Energy, points to the need for continuing OUR support for this important service. The accident information and data on treatment generated by DAN are used to increase the public's awareness of diving-related accidents by means of workshop reports and other publications.

Proceedings of the Eighth Symposium on Underwater Physiology

In 1983, NOAA joined with the Office of Naval Research and the University of Pennsylvania's Institute for Environmental Medicine to sponsor the eighth in a series of triennial meetings on the laboratory and clinical aspects of underwater medicine and physiology.

The Eighth Symposium on Underwater Physiology was held in St. Jovite, Quebec, Canada, and was attended by scientists from all oceanographic disciplines and many countries. The *Proceedings* of the symposium will be published in 1984, and plans are underway for the Ninth Symposium, to be held in Amsterdam in 1986.

NOAA Diving Manual—Third Edition

The Office of Undersea Research has begun the revision and updating of the *NOAA Diving Manual*, last revised in 1979. The *NOAA Diving Manual* is the Government Printing Office's bestseller, with 21,332 copies sold since the second edition was published. The *Manual* is designed for use by NOAA divers, scientific and educational divers, and recreational divers throughout the continental United States. It will include state-of-the-art material on diving physiology, diver training, diving equipment, emergency procedures, procedures for performing various underwater tasks and scientific diving, discussions of various breathing media, and surface-support and underwater platforms. OUR anticipates publication of the third edition of the *NOAA Diving Manual* in 1986.

U.S. GOVERNMENT PRINTING OFFICE: 1984 - 464-052 - 814/20532

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